POWER

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The Material and the Immaterial

WHEN I was a boy and P. T. Barnum was in his prime, his Big Show included a talking machine.

It was a clumsy imitation of the human tongue and palate and, actuated by a bellows, would articulate, thickly and indistinctly, a few simple words.

Today a simple diaphragm vibrated by a needle running in a groove or by magnetic impulses reproduces the human voice with such fidelity that the identity of the speaker may be recognized.

A story used to be told of a savage who marveled at the man who could "make a chip talk," because he made him the bearer of a message written upon a piece of wood.

We passed, in communication, from the days of the courier and mail coach to the telegraph, which marked its message on a tape in dots and dashes. It was not evident in advance that the ear of the operator could catch those dots and dashes as they came in and that the recording of them upon the tape would be unnecessary, but so it proved and the sounder replaced the recorder.

And then came the telephone, making it possible to chat or discuss affairs with anyone to whom a wire could be strung, with much of the satisfaction of an actual visit.

And now even the wire has become unnecessary and the air is full of music and eloquence, of information and entertainment that anyone with a simple apparatus that a boy can build, can pick up in his home.

And we are beginning to have intimations of the possibility of seeing at a distance.

At the Centennial Exposition in Philadelphia fifty years ago the power generated by the great Corliss engine was transmitted to the exhibits in Machinery Hall by long lines of geared shafting underneath the floor. Up to comparatively recent times universally, and now to a large extent, power generated by prime movers was conveyed by gears and enormous belts and rope drives to long mainshafts running through the mills.

I remember listening to a discussion between the agent of a New England textile mill and Capt. Charles H. Manning as to the handling of the increasing units of power. "It isn't going to be possible to make belts to do it," said the agent, "Cattle don't grow large enough."

Captain Manning came back with, "We shall have to drive the cattle faster."

Now a simple conductor, underground or overhead, direct or circuitous, leads power to any distance, with some vagaries of its own it is true, but with none of the old troubles of alignment, limitations as to distance and direction, clutter, encumbrement and constant attention.

And so, in many things we are passing from the slow, cumbersome and material to immaterial forces and agencies the existence of which was unsuspected a few generations ago.

And scientists now tell us that the atom, which we were taught was the indivisible unit of matter, is composed of electrons and protons, and that these appear to be nothing more than centers of energy, so that in the last analysis we shall have to get a new conception of materialism, or admit that we and everything that we know is immaterial.

F. R. Low

Power as a Byproduct of Process Steam

Condensing Operation of Prime Movers Not Always Best—Demand for Exhaust Steam Makes Non-Condensing or Bleeder Operation Advisable—Combined Power and Heating Plant Gives Highest Efficiency

By W. G. DIMAN
Superintendent of Power, Amoskeag Manufacturing Company

IN VIEW of the fact that the most modern condensing public service steam plant has a plant efficiency little over 20 per cent with probably less than 15 per cent at its outside delivered current point, we may well ask ourselves if we are getting all that we should from the heat units in a pound of fuel.

While there have been great strides made in the designs of the various apparatus to utilize heat, still

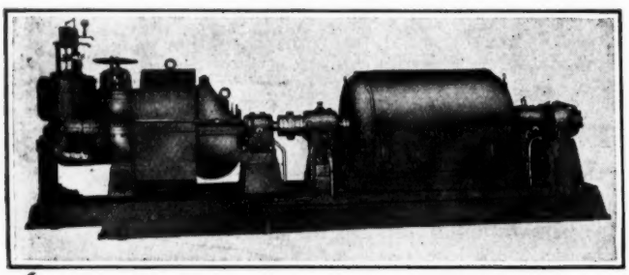


Fig. 1—Small bleeder-type turbine such as used in plants when process steam demands are low

the percentage gained in the total amount of heat utilized to produce power has not increased in like proportion. Consequently, the question arises, Is not some other form of heat utilization still to be brought forth to produce more efficient results than are attainable in modern plants whose sole output is electric energy? This is easier to ask than to answer, but one thing is certain—more efficient utilization of heat is possible with what we have at present than is being done today. This should be taken advantage of, and every B.t.u. in a pound of fuel should deliver its maximum result in all places. Greater efforts should be made along these lines.

Fuel Conservation Important

It is not only a question of obtaining the greatest use from each heat unit, but it is also a matter of fuel conservation. We are today burning coal in a central station to generate electric energy to be used in industrial plants, while at the same time these factories are burning coal to supply steam heating. Public service companies are selling current to many factories, which could be produced much more economically in the factory's own plants. Engines and turbines are being run condensing in many places where steam is needed for process work, and in addition fuel is being consumed for the process work.

In the modern plant one of the big savings, aside from the design, is being made by stage heating coupled with the auxiliary apparatus in connection with it. This is nothing more or less than heating feed water with exhaust steam taken from different points in the turbine depending on the temperature desired. I think the time will come when heat and power will be coordinated so that part or all of the heat, light and power will be supplied from one central source. This should be done. While this idea may seem a little radical, I think there is considerable food for thought in it. We might pause a moment and give some study to such a plan applied to some of the future power developments.

In many localities no thought at all is given as to how buildings are to be heated, lighted or supplied with power. There is a great field today for extraction and non-condensing turbines and engines as well as for all types of prime movers and auxiliaries.

Coupled with a proper selection of prime mover, is a field for improvement in the industrial apparatus that utilizes the heat. With study many improvements can be made which will allow a much lower steam pressure to be used as well as less heat to accomplish the same result. Much of the industrial apparatus which requires steam in its use is today operating along the same line as 25 to 30 years ago. Little thought has been given as to how much steam is necessary to accom-

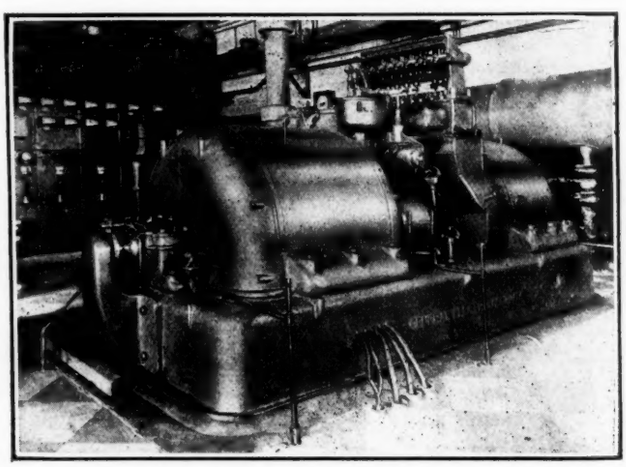


Fig. 2—Non-condensing turbine delivers its exhaust into heating mains

plish satisfactorily the work required in the specific industrial apparatus. The pipe line is connected to the apparatus and the operator opens up the valves—this is all that is known in the plant.

Of course sufficient study must be given to any proposed development, and when the increased cost and overhead overbalances the savings made, compromises are necessary. Combinations will also have to be made covering such situations as a required steady load coupled with variable process-steam demand, etc. There should be agreements between public service and industrial plants arranged on a give-and-take basis to meet

load fluctuations, and the price should be fair to each. There can be a great deal more co-operation than exists at present. Greater efforts should be made to utilize all heat, no matter in what plant situated, and instead of stifling its proper use, there should be, on the part of all, co-operation to accomplish this result.

The variation in the load due to the process steam can be taken up by other plant units or by mutual agreement with outside power companies. If the plant load is greater at times during the day, power could be furnished to the public service company, or if less, the difference could be furnished by the public service plant and reasonable prices charged for this exchange.

High Back-Pressure Turbine at Amoskeag

One interesting development along this line has just been completed in the woolen department of the Amoskeag Manufacturing Co. Here a 5,000-kw. non-condensing turbine has been in operation for two months. It is at present operating with 150 lb. steam pressure against 27 lb. gage back pressure. Some of the high-pressure blading has been left out, as the turbine was designed to operate ultimately with 225 lb. pressure, 100 deg. superheat, and with from 25 to 35 lb. (gage) back pressure.

The daily curve shown in Fig. 4 gives an average line on the load. The turbine was operating at the time with 141 lb. throttle pressure, 35 deg. superheat, against 26 lb. back pressure.

All the process steam for the woolen department is being furnished from the turbine at 27 lb., and the work is being done satisfactorily. Formerly, this steam was furnished direct from the boilers at 100 lb. pressure. This plant has considerable water power together with six steam turbines and several engines, so that any variation in the process steam demand affecting the non-condensing turbine load, can easily be taken up by the other units. The load, however, is fairly constant.

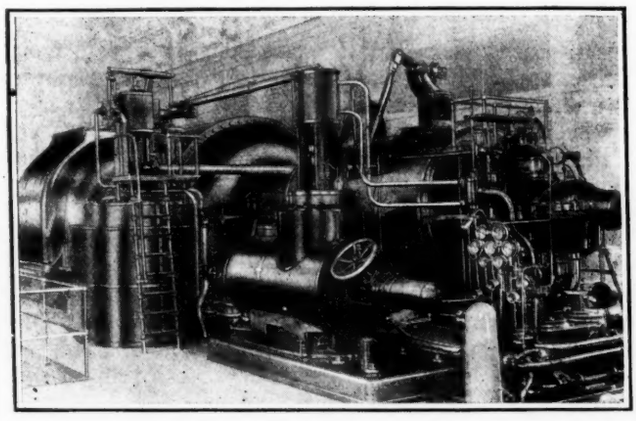


Fig. 3—Mixed-pressure turbine used with a reciprocating steam engine when the heating demands vary widely

The turbine has a back-pressure regulating valve connected to the governor, so arranged that it will maintain a constant turbine back pressure, varying the load to accomplish this. The regulator has a 10-lb. range and can be set at any point from 25 to 35 lb. The turbine exhausts into a 30-in. line, which in turn delivers steam into two 18-in. mains running into the plant. One main goes north and the other south, requiring a steam travel in each main of from 900 to 1,000 ft. The 30-in. line is protected by a 24-in. atmospheric relief valve and each 18-in. main by a 12-in. atmospheric relief valve.

The average conditions of the pressure and temperature drops in these mains with the various loads are given in the table.

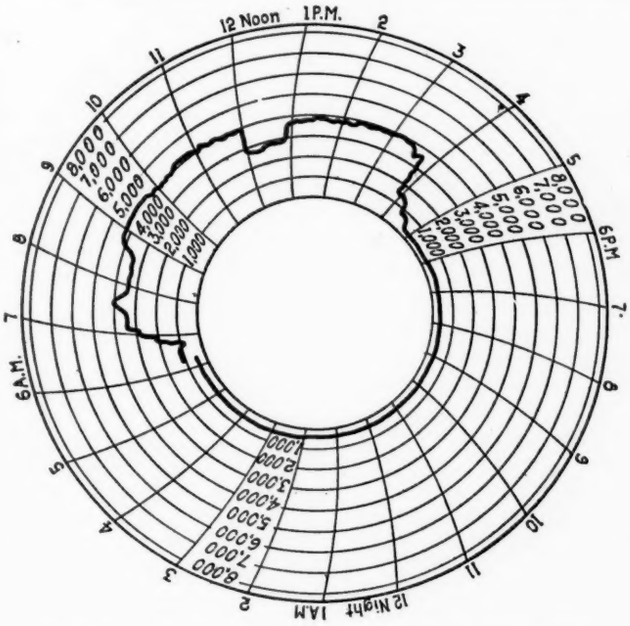


Fig. 4—Daily steam output record at Amoskeag

VARIATIONS IN PRESSURE AND TEMPERATURE IN THE MAINS

Load Kilowatts	Temperatures, Deg. F. Turbine Exhaust	End of South Line	End of North Line	Pressures Lb. per Sq. In. Turbine Exhaust	End of South Line	End of North Line
1,000	274	273	265	26	25	23
1,600	272	268	268	26	24.5	24.5
2,200	270	267	266	25	23	23
2,600	273	270	266	25.8	24.2	23.1
2,900	271	268	266	25.1	21	23.1

Between the high-pressure drum and the two 18-in. exhaust steam lines there are two 6-in. and one 8-in. bypasses operated by chronometer valves and controlled with damper regulators. These regulators are set about 2 pounds lower than the turbine exhaust pressure, and in case the turbine shuts down they will automatically open up, allowing steam from the boilers to pass through into the low-pressure mains at the pressure at which the regulators are set. The turbine furnishes steam for process use during the mill operating hours; at other times it is furnished through these bypasses.

This non-condensing unit averages a kilowatt-hour on much less than a half a pound of coal, and the cost per delivered kilowatt-hour, which includes not only the overhead cost of the turbine installation but all work done in the plant to utilize the lower pressure, will average well below one-half cent.

While this may be an exceptional condition, there are in operation today many plants that could be operated in much the same manner. The idea must be given up by manufacturers that exhaust steam cannot be used for industrial purposes.

There is a large field for power engineering aside from the development of new plants, and large savings can be made through the proper utilization of heat units in existing plants combined with a proper coordination of heat units in the plant locality.

Developing a 14,000-Hp. Water Power 9,000 Ft. Above Sea Level

BY ROBERT R. BENSON
Construction Department, Southern Sierras Power Company, Riverside, Calif.

Leevining Falls at low water

CONSTRUCTION of a 14,000-hp. water-power project 9,000 ft. above sea level involves something more than might be expected, except by those who have actually taken part in such an undertaking. This is particularly true on the eastern slope of the Sierra Nevada mountains in California, where the Leevining Creek development of the Southern Sierras Power Co., which was started in 1921, is located.

Three plants are planned for the Leevining Creek project, of which No. 3, the smallest and lowermost, was put into operation in January, 1924. This plant has a capacity of 4,000 hp. in a single unit and operates under a 300-ft. head. Plant No. 2 has not progressed beyond the stage of preliminary surveys, but will operate under a 600-ft. head when built. Plant No. 1, which has a capacity of 14,000 hp. in a single unit, operates under a 1,700-ft. head and went into operation in October of last year.

This last-named project involved the erection of a dam at the outlet of Rhinedollar Lake, which forms a forebay covering 70 acres of mountain meadow 9,500 ft. above sea level; the construction of a tunnel 2,700 ft. long through granite rock; laying of 2,250 ft. of pressure pipe 26 in. in diameter at the plant and 48 in. in diameter in the tunnel, for a total static head of 1,700 ft.; and construction of a 14,000-hp. plant with a single 10,000-kva. generator mounted on the shaft of a single overhung impulse wheel. This wheel is one of the largest units ever equipped with a deflector of the sleeve type for controlling speed. To deliver the power to the company's system required the construction of a 110,000-volt line 23 miles long to Rush Creek, whence the transmission line continues into Southern California. The natural reservoir from which the water supply is taken directly is Saddlebags Lake, whose capacity has been increased to 10,000 acre-feet by a 30-ft. rock-filled dam with timber face.

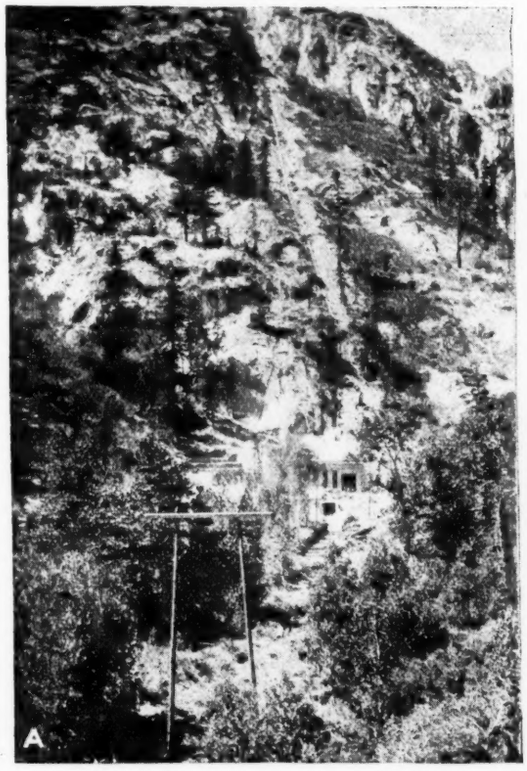
Two natural conditions militate against construction work on the east slope of the Sierra Nevada Mountains in California. The desert valleys extending along the eastern base of the range, of which Owen Valley is the largest, gives way abruptly to the rocky mountain slopes, rising to a crest over 10,000 ft. in elevation. The two elemental forces forming the chief obstacles to the building and maintenance of structures for water-power developments are (1) the desert sands and volcanic dust which defy all efforts at road maintenance and (2) the extreme cold of winter which, together with the sudden changes of temperature, militates against the permanence of concrete structures.

Roads from Benton and from Laws through Bishop, Calif., the distributing points for material coming in over the narrow-gage railroad, lead through a barren, sage-brush land where volcanic action has blanketed the plateaus under a depth of loose volcanic sand or suffocating unstable volcanic dust. The marked absence of foothills along this eastern mountain base, renders extremely steep the grades of all roads into the highlands, a condition greatly aggravated by the depth of dust and sand. Another adverse circumstance is the seasonal distribution of rainfall in this arid land. During the summer, when all construction work is done, scarcely a drop of rain falls, and this is the season above all others when, for the roads' sake, rain is most needed. Rainfall during the winter of 1923-24 was the least recorded for many years back, and the last summer passed without a single transient shower and with scarcely an indication of the summer thunderstorms which occasionally break over the high Sierras.

Difficulties in Transporting Machinery

Water was lacking last year along the road from Benton to Leevining Creek, and the road was reduced to a 56-mile stretch of pulverized crater-dust which serves only to conceal the deep ruts of the wheel tracks. In the effort to hold the road up under the heavy traffic, every practicable method of desert road making was tried, and all failed after serving a temporary need. Sawdust and chips from the old Mono sawmill were hauled into the six-mile stretch beneath the Mono craters, but to no avail. Sage brush was strewn deep in the wheel tracks, but after the passage of a couple of trucks the brush was chewed to bits and was ineffective. Grading only made the road worse by filling the wheel-tracks deeper with sand.

As a result, trucks came into Leevining Creek some with frames broken under the weight of heavy machinery jolting over the ruts; some with cylinders scored by volcanic emery inhaled through the carburetors. Those of us who appreciate the battle involved in every trip into Leevining "take off our hats" to the truck drivers who literally buck their way across the ridges, sand and desert wastes of the Benton road. We have seen them so "fagged out" by continuous shifts at the wheel that they have fallen asleep at the throttle while on the road, and one lad drove off the canyon road and was only saved from toppling into the creek by a providential tree against which the truck load of flow-pipe lodged. But still the freight came in, Pelton machinery, transformers, pressure pipe, cement, wire, poles, crossarms and camp supplies. The destructive forces of the desert and of the craters have expended themselves in vain, the company won in spite of all and the plant was completed.



A. Plant No. 1 Leevining Creek

At the center of the picture can be seen the power house with the penstock, which extends up the mountain side for 2,250 ft. where it connects to a tunnel 2,700 ft. long leading to the forebay 9,500 ft. above sea level. The plant has a capacity of 14,000 hp. in a single unit operating under a 1,700-ft. head.

B. Hauling a 17-ton load over the desert road from Benton to Leevining Creek, 63 miles in 9 days

A 45-hp. and a 60-hp. tractor co-operated in the task.

C. Packing sand to Rush Meadow dam, 10,000 ft. above sea level

D. On the tramway Leevining Creek

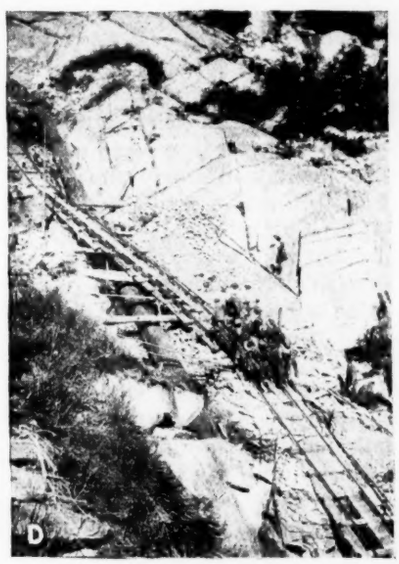
The penstock can be seen below the tramway on the left.

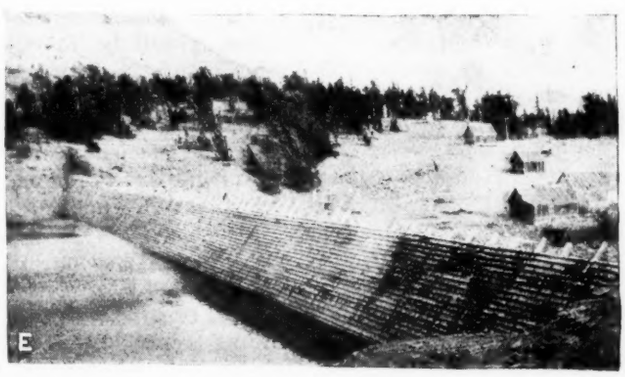
E. Board-faced rock-filled dam at Lake Saddlebags at elevation of 10,500 ft. above sea level

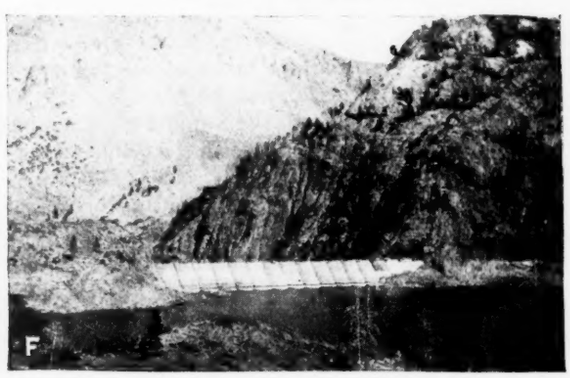
This type of dam is the most economical at this altitude. Mount Dana can be seen in the left background elevation, 13,050 feet.

F. Gem Lake multiple-arch dam at low water, elevation 9,030 ft.

The arches were treated with various surfacing materials in experimenting on waterproofing the cement to prevent freezing in winter. All these failed and the arches were filled solid with concrete as the last resource against leakage caused by winter freezing.







Large Curtis Turbines*

By O. F. JUNGGREN
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SIMPLIFICATION of design is the underlying means of securing reliability. Development of both turbine and generator has been carried on in equal degree as far as possible so that a balanced unit of one turbine cylinder with a single generator may be produced. Leaving loss, or that which is due to the velocity of the steam leaving the last bucket row, is held to a moderate amount by simple blade design.

IN HIS admirable paper on steam turbines and condensers presented at the World's Power Conference, last July, Mr. Hodgkinson indicated the growth and present tendencies of the turbine industry in the United States. However, his paper very naturally was based primarily on the development of the turbine manufactured by the Westinghouse company. In order more completely to indicate the situation in the turbine industry as a whole in the United States, the liberty is being taken of supplementing his paper with a brief statement of what the General Electric Co., as a manufacturer of the Curtis type of turbine, has done and is doing to promote the cheap and reliable generation of electric power. This company has always recognized the advantages of large units in lower fuel and capital charges. The development of large turbines may be briefly summed up in three classes:

1. Turbines made with Curtis combined velocity stages throughout. These were mostly made of the vertical type with comparatively few stages and slow speed to suit the generator development at that time, and were manufactured from 1902 to 1914 in sizes up to 20,000 kw.; total capacity 2,163,700 kw. in 783 units.

2. Turbines having one combined velocity stage with a varying number of single wheels. This type of machine is still in active production except for the largest sizes. The Curtis combined velocity stage has been generally adopted by various turbine manufacturers, both reaction and impulse, as being a convenient method of utilizing a high heat drop. There are installed and on order 234 units of this type, with a total capacity of 3,250,000 kw. in sizes of 10,000 kw. and larger.

3. Turbines with single wheels throughout and the characteristic conical construction of rotor, giving a full admission and uninterrupted path for the steam from the beginning to the end, producing a simple and efficient turbine. There are installed and on order 133 units of this type in capacities of 15,000 kw. and larger, totaling over 4,000,000 kw.

This type of turbine was put on the market in 1915. From the beginning it met with great favor and gave the electrical industry a unit of large capacity, exceedingly simple in its construction and highly efficient. Its success may be judged by the large number of machines of this type that has been produced. At the present time there are fifty 30,000-kw. units at 1,800 r.p.m. in actual service, with nineteen additional on order for installation in the near future.

A line of these machines was developed, which consisted of designs for 25,000 to 30,000 kw. 1,800 r.p.m.; 35,000 to 40,000 kw. 1,500 r.p.m.; and 45,000 to 50,000 kw. 1,200 r.p.m.

One of these machines is shown in Fig. 1. This type of turbine is very flexible in order to meet the varying steam conditions, which were about 230 lb. gage in 1914, and at the time of writing (July, 1924) about 375 lb.

The underlying idea in the general development of the General Electric turbine units has been reliability through simplicity, and to develop the turbine as the generator has developed, thereby securing a balanced combination giving the highest efficiency. By so doing complications are avoided incident to the combination of several generators and turbines in order to obtain a large capacity. The final measure of efficiency of a turbine unit, of course, is its performance in the station. This is an entirely different proposition from the analysis of the internal losses in the turbine, whether in the last blade or in other parts of the machine. The accompanying table gives test performance on machines in actual commercial operation.

Demands for Better Economy Grow with Increased Electrical Load

According to the Geological Survey the average total production of electricity by public utility power plants in February, 1924, reached the large figure of 168,300,000 kw.-hr. per day, of which 114,000,000 kw.-hr. were produced by fuel. As an illustration this represents 158 30,000-kw. units operating at full capacity continuously for 24 hours. An industry of such magnitude and still growing at a very rapid rate requires the highest efficiency for its maintenance and growth, and there is an insistent demand for higher and higher economy.

The development of the steam turbine has now reached such a point that any great advancement in the efficiency cannot reasonably be expected, although we may expect some further advancement by study and persistent research regarding the behavior and action of steam in buckets and nozzles. Such research is continuously being pursued by the General Electric Co. However, the greatest advancement will be found in increasing the pressure and temperature in conjunction with bleeding for heating the feed water and reheating the steam after it has done a certain percentage of the total work. This increases the efficiency of the steam cycle as well as the steam turbine due to reduction of moisture, and, in addition, it should considerably reduce bucket deterioration.

The General Electric Co. has built and has on order for the electrical industry in the United States at the present time a total of 460,000 kw. turbine generating capacity at steam pressures ranging from 530 to 600 lb., total temperature of steam 725 deg. F., and reheated to 725 deg. F. at a pressure of about 110 lb. In addition, such units are arranged for multi-stage extraction for

*Discussion of F. Hodgkinson's paper, "Steam Turbine and Condensing Equipment," presented at the World's Power Conference. July, 1924.

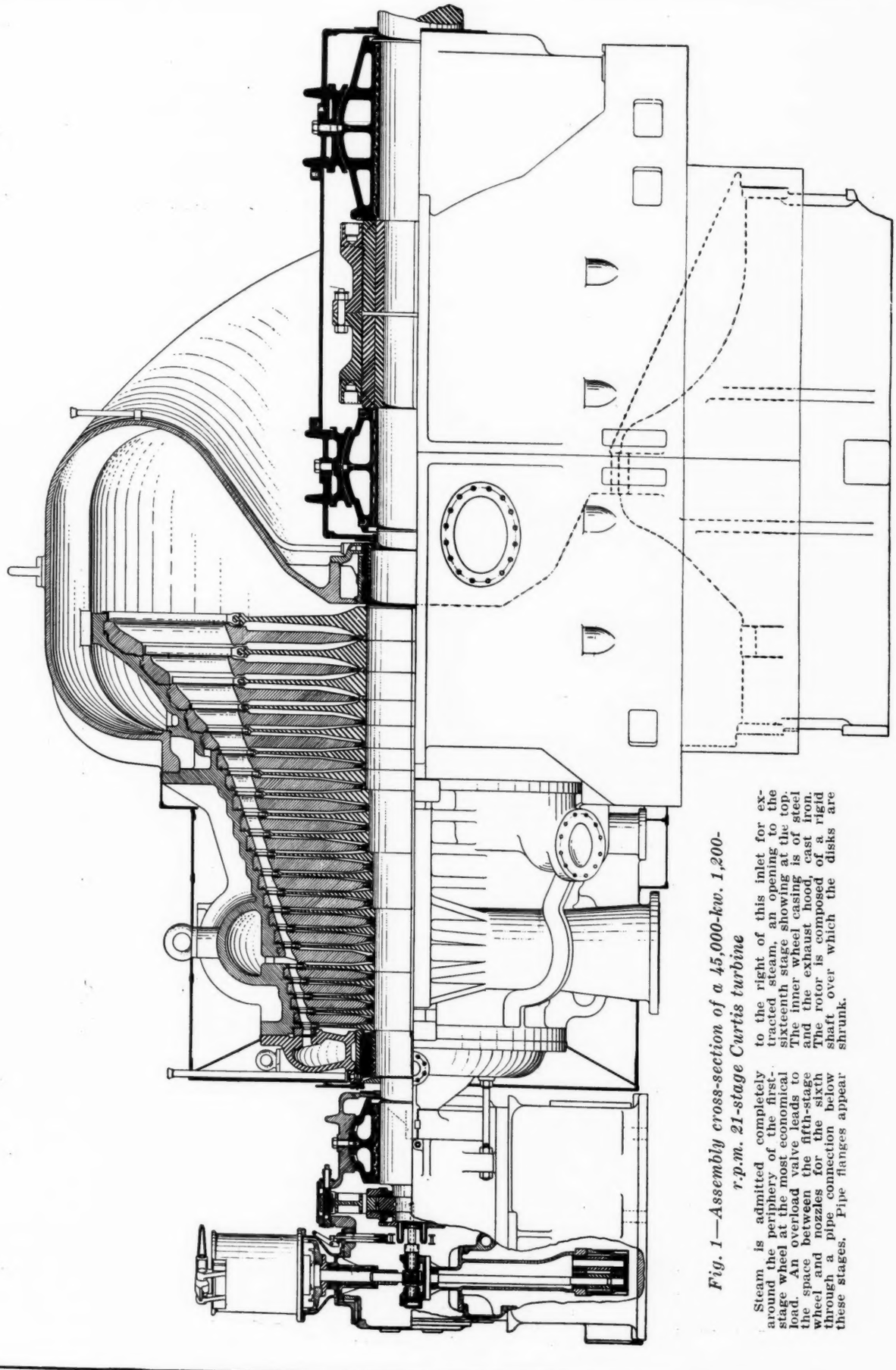


Fig. 1—Assembly cross-section of a 45,000-kw. 1,200-r.p.m. 21-stage Curtis turbine

Steam is admitted completely around the periphery of the first-stage wheel at the most economical load. An overload valve leads to the space between the fifth-stage wheel and nozzles for the sixth through a pipe connection below these stages. Pipe flanges appear to the right of this inlet for extracted steam, an opening to the sixteenth stage showing at the top. The inner wheel casing is of steel and the exhaust hood, cast iron. The rotor is composed of a rigid shaft over which the disks are shrunk.

Steam at 550 lb. gage 725 deg. F. is admitted at the right, being exhausted at about 110 lb., after which it is piped to the boiler and reheated to 725 deg. for use in the low-pressure turbine, Fig. 3. In addition to its main alternator, this turbine also drives an alternating-current-auxiliary turbine of 2,000 kw., the entire unit being 58 ft. long.

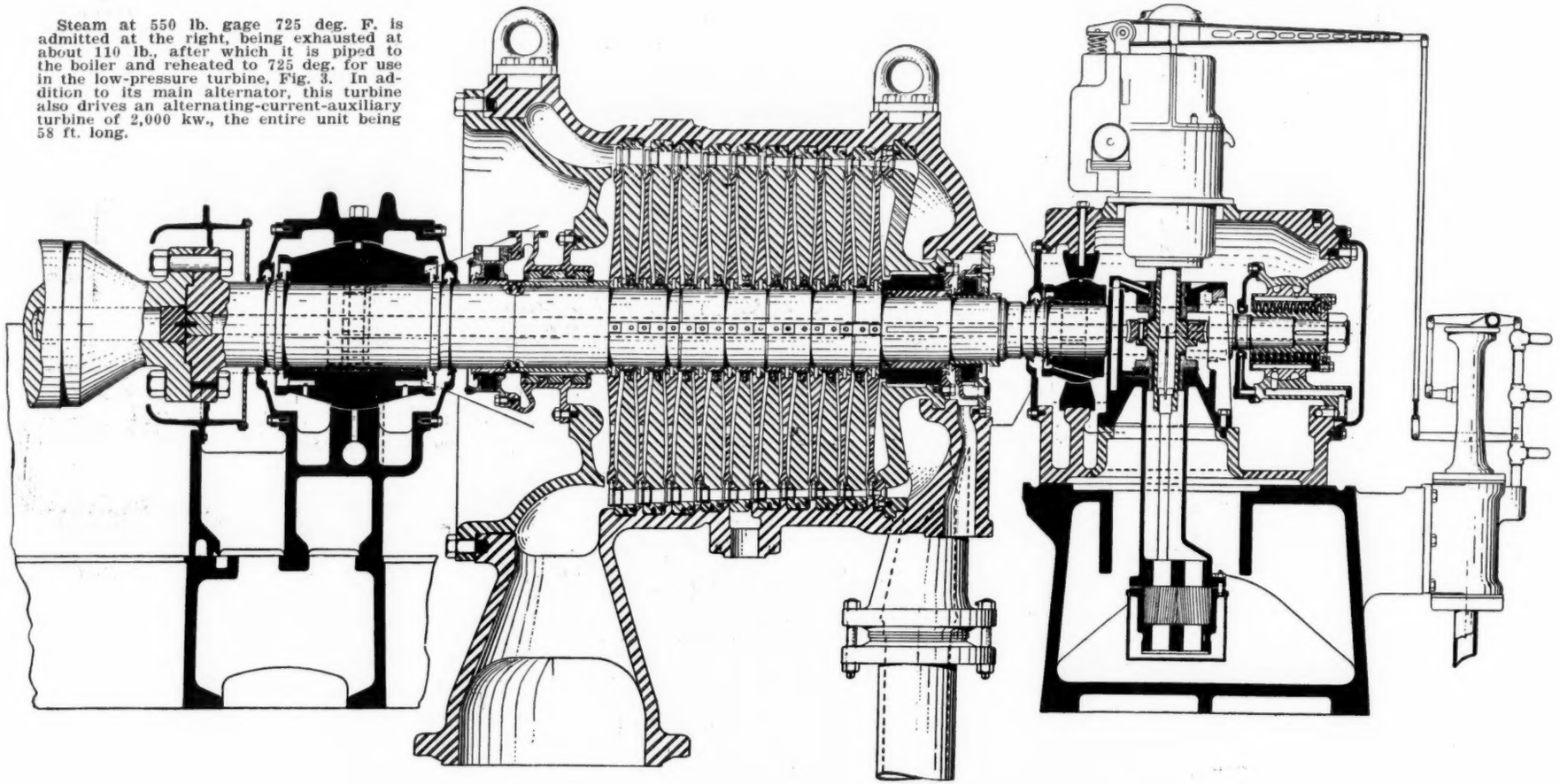
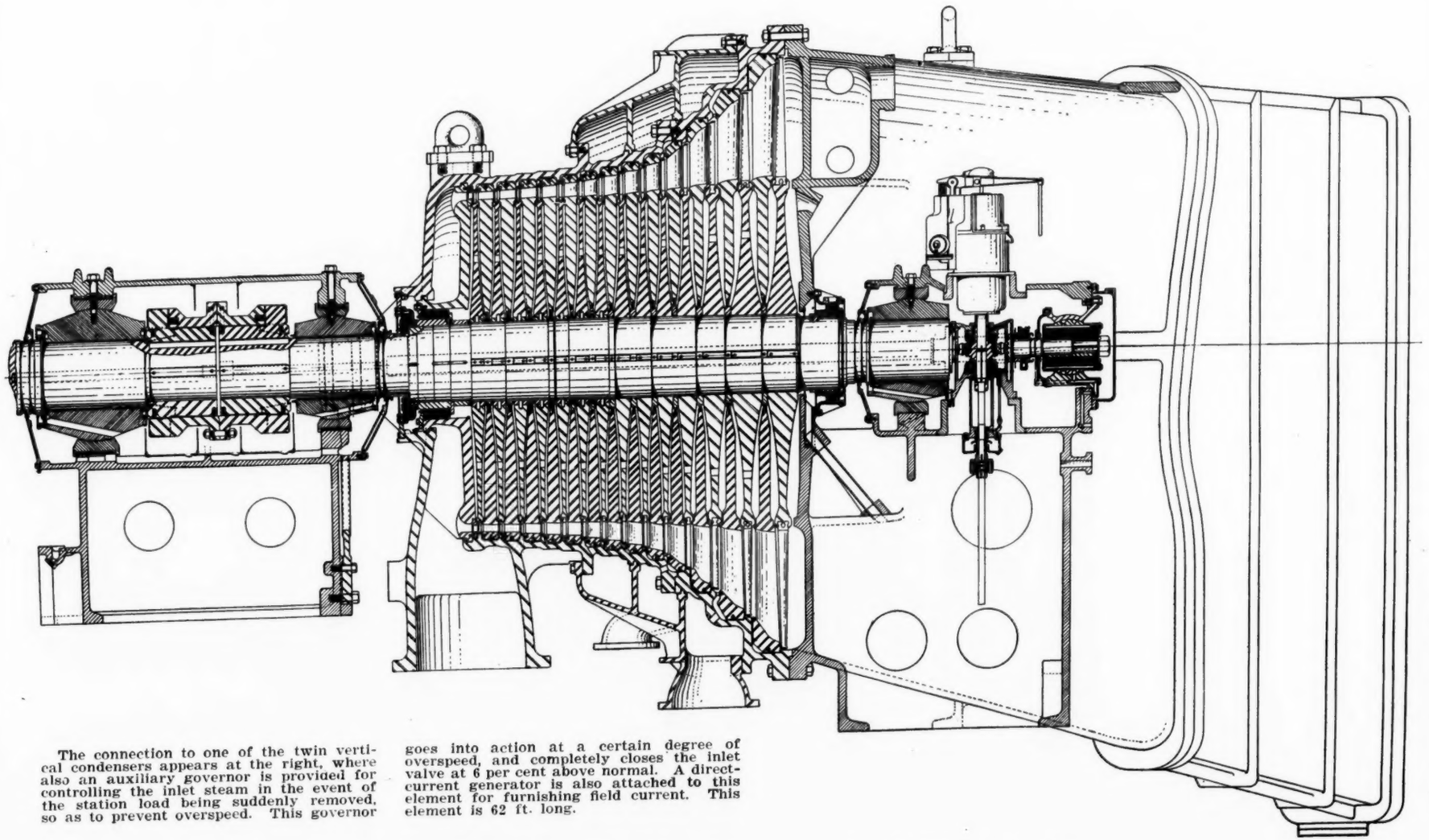
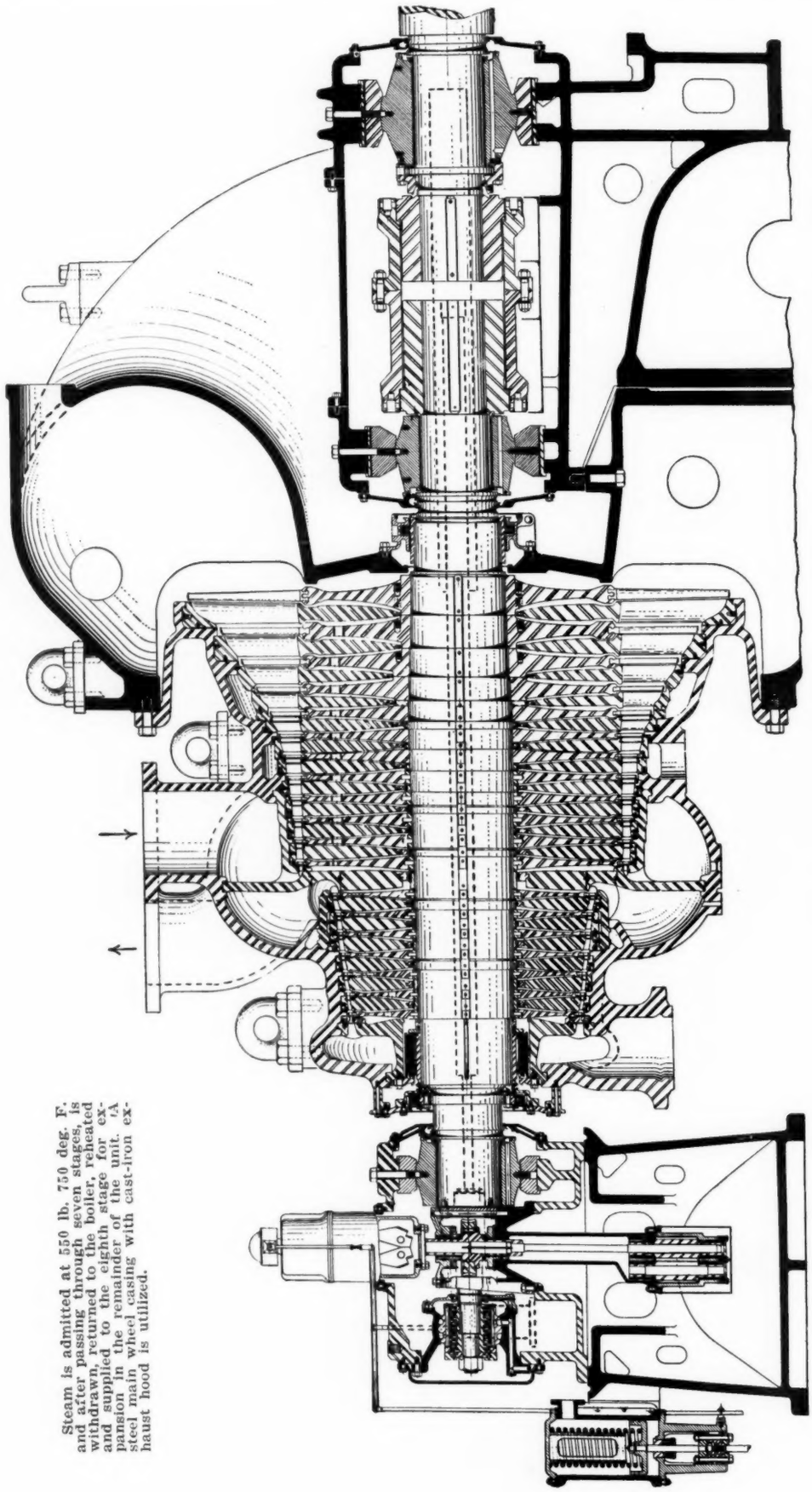


Fig. 2—17,000-kw. 1,800-r.p.m. 10-stage high-pressure element of 60,000-kw. turbine



The connection to one of the twin vertical condensers appears at the right, where also an auxiliary governor is provided for controlling the inlet steam in the event of the station load being suddenly removed, so as to prevent overspeed. This governor goes into action at a certain degree of overspeed, and completely closes the inlet valve at 6 per cent above normal. A direct-current generator is also attached to this element for furnishing field current. This element is 62 ft. long.

Fig. 3—43,000-kw. 1,200-r.p.m. 14-stage low-pressure unit of 60,000-kw. turbine



Steam is admitted at 550 lb. 750 deg. F. and after passing through seven stages, is withdrawn, returned to the boiler, reheated and supplied to the eighth stage for expansion in the remainder of the unit. A steel main wheel casing with cast-iron exhaust hood is utilized.

Fig. 4—35,000-kw. 1,800-r.p.m. 19-stage reheating design, one unit of which at Philo, Ohio, is the first commercial turbine operating at 550 lb.

heating feed water. Among these installations may be mentioned:

One 60,000-kw. unit for the Commonwealth Edison Co., Chicago, Figs. 2 and 3. This consists of two separate turbines and generators. The high-pressure unit operates at 1,800 r.p.m., developing 17,000 kw.; the low-pressure at 1,200 r.p.m., developing 43,000 kw.

Eight 35,000-kw. to 40,000-kw. units for the American Gas & Electric Co., which operate at a speed of 1,800 r.p.m., and, as Fig. 4 shows, have the reheating feature in one complete turbine casing.

Two 40,000-kw. units for the Columbia Gas & Electric Co., which are of the tandem type, operating at 1,800 r.p.m.

The efficiency guarantees for these turbine units range from 10,450 to 10,300 B.t.u. per kw.-hr. at the above-stated steam conditions and 29 in. of vacuum, with two- and three-stage bleeding for heating feed water up to 245 deg. F.

One 2,600-kw., 3,600-r.p.m. unit for the Boston Edison Co. to operate at 1,000 lb. steam pressure, total temperature of 700 deg. F., discharging the steam at 360 lb. pressure for use in the regular steam turbine. This unit will be in operation shortly.

Requirements of Modern Power Plant

The modern power station is not so simple as it was ten years ago and will require the highest degree of skill for its operation and maintenance in order to obtain the high efficiency for which it was designed.

When various turbine constructions are discussed, the writers usually place great stress upon what is termed the leaving losses of a turbine; that is, the loss in the last blade row. In order to reduce these, numerous devices have been proposed, and there is the double flow, parallel double flow and multiple flow, all with the object of reducing this loss to a minimum, but in so doing other losses are assumed, such as increased leakage losses, losses due to eddies and carry-over losses. Often the losses incident to such constructions counterbalance the gain in the leaving loss without any improvement in the net result, but the complication remains. A much simpler arrangement is to avoid such constructions, giving attention to substantial bucket fastening and non-vibrating buckets, which will produce a moderate leaving loss. It is more than likely that no bucket failure ever occurred in any turbine due to centrifugal force alone. It is always combined with vibratory and heat stresses. By avoiding these, especially stresses due to vibrations, there may be safely produced a comparatively long bucket. Vibrations of any kind must be avoided in turbines, especially in the wheels and buckets, and such vibrations may be present, although the machines as a whole operate well. This subject is dealt with in a most thorough and complete manner by Wilfred Campbell in his paper, "The Protection of Steam-Turbine Disk Wheels from Axial Vibration," presented at the spring meeting of A.S.M.E. at Cleveland, Ohio, May 28, 1924.

Of late there has been a considerable increase in the bucket speed of all turbines, and the reaction turbines that only a few years ago considered low speed essential have materially increased such speeds. The idea that complete safety of a turbine lies in low speed is gradually disappearing with a realization that machines operating at comparatively high velocities are just as safe as those at lower ones. The stored energy in a turbine, even at low speeds, is of such magnitude that in case something unusual happens the destructive force is sufficient to destroy the machine. The safety in a turbine lies in avoiding heat and vibratory stresses. If they are present, it is only a question of time when trouble will occur, whether the machine is called low-speed or high-speed.

If the past is any indication of what will happen in the near future, there will be still further insistence upon increase in economy in the production of power. There appear to be two ways in which this may be accomplished. The first is by using W. L. R. Emmet's mercury process in combination with the steam cycle at comparatively moderate pressure, and the other is to increase the pressure and temperature of the steam, both having the object of increasing the economy through an increase of temperature range. The steam turbine is perfectly capable of utilizing as high steam pressures and temperatures as can be generated, and in the near future we may see large turbine units operating on pressures as high as 1,500 lb. in as satisfactory a manner as present-day units.

The trend in the power field in the United States is toward consolidation and concentration, resulting in a demand for larger and larger turbine units, and sizes of 100,000 kw. and over may be considered in the near future. The design will vary from present-day construction, but there does not seem to be any limitation to the size of units that can be produced except demand.

STEAM CONSUMPTIONS OF GENERAL ELECTRIC HIGH-PRESSURE TURBINE UNITS OBTAINED DURING OFFICAL TESTS CONDUCTED JOINTLY BY PURCHASER AND MANUFACTURER

All units listed are single-flow type in a single casing.
I—35,300 kva. (0.8 p.f.), 1,800 r.p.m., 60 cyc., 17 stage Cahokia Station, Union Elec. Lt. & Pr. Co., East St. Louis, Mo.
II—35,300 kva. (0.8 p.f.), 1,800 r.p.m., 60 cyc., 17 stage Lakeside Station, Milwaukee Elec. Lt. & Pr. Co., Milwaukee, Wis.
III—31,250 kva. (0.8 p.f.), 1,800 r.p.m., 60 cyc., 20 stage L Street Station, Boston, Edison Ill. Co., Boston, Mass.
IV—35,000 kva. (1.00 p.f.), 1,500 r.p.m., 25 cyc., 20 stage, Northwest Station, Commonwealth Edison Co., Chicago, Ill.
V—35,000 kva. (1.00 p.f.), 1,500 r.p.m., 25 cyc., 20 stage, 59th Street Station, Interboro Rapid Transit Co., New York, N. Y.
Note: All units except No. V have direct-connected exciters. The excitation for No. V is from a separate source and is deducted from the generator output.

		I	II	III	IV	V
Steam Conditions Ahead of Throttle Valve	Pressure in Lb. G.	300	260	300	240	210
	Temperature in Deg. F.	707	587	616.6	584.8	503.5
	Superheat in Deg. F.	285	178	194.6	182.1	111.6
Power-factor		0.87	0.83	0.86	1.00	1.00
Exhaust Press. 1 in. Hg. Abs. (Measured in Plane of Turbine Exhaust Flange)	Kw. load with primary control valve wide open, secondary valve disconnected	29,500	25,500	24,000	24,750	25,500
	Water rate with packing leakage returned to lower stage of turbine—in lb. per kw. hr	9.32	10.43	10.04	10.33	11.00
	Overall Rankine cycle efficiency in per cent (Marks and Davis Steam Tables)	78.35	76.00	76.56	77.52	77.32
	Overall Rankine cycle efficiency in per cent (Callendar's Steam Tables)	77.15	75.20	75.60	76.70	76.76
Exhaust Press. 1.5 in. Hg. Abs. (Measured in Plane of Turbine Exhaust Flange)	Kw. load with primary control valve wide open, secondary valve disconnected	28,485	24,695	.....	.....	.....
	Water rate with packing leakage returned to lower stage of turbine—in lb. per kw.-hr	9.64	10.77	.....	.....	.....
	Overall Rankine cycle efficiency in per cent (Marks and Davis Steam Tables)	79.10	77.05	.....	.....	.....
	Overall Rankine cycle efficiency in per cent (Callendar's Steam Tables)	77.90	76.25	.....	.....	.....

New Fairbanks-Morse Diesel Oil Engine

TWO-STROKE-CYCLE solid-injection engine employing a compression of 500 pounds. A feature is the grouping of the fuel pumps, air-starting valves and governor-control mechanism in a compact, accessible unit at the end of the mainshaft.

A NEW design of oil engine, operating as a full Diesel without the use of auxiliary ignition, the compression being 500 lb., has been developed by Fairbanks-Morse & Company. Being a development from the former type *Y* moderate-compression oil engine, it is similar in general form and manner of operation, in that it is of the two-stroke-cycle, solid-injection type, retaining crankcase compression for scavenging.

An outstanding feature in the new engine is the design and arrangement of the fuel injection and governing system. Reference to Fig. 1 will show a compact inclosed unit at the right end of the mainshaft. This contains the injection system and the mechanism for governing, air starting and fuel control. The fuel pumps are grouped on a pump deck and inclosed in a case serving as the fuel-oil reservoir. As the pumps are submerged, they operate under a slight head, suction piping is eliminated and the possibility of their becoming airbound is avoided.

Individual Injection Pumps

Each cylinder has its injection pump, their arrangement for a six-cylinder unit being shown in Fig. 3. In addition there is an auxiliary plunger pump operated by a rocker and connected to an eccentric on the main engine shaft, which draws fuel from the auxiliary supply tank and delivers it into the reservoir housing the injection pumps.

One cam on the governor shaft operates all the injection pumps through a series of rollers and rockers, equally spaced around the circumference of the shaft. Another cam on this governor shaft operates the suction-control valve for each of the injection pumps, the drive being the second row of rollers and rockers shown in Fig. 3. In this same illustration it will be noticed that there is a third roller and rocker, which serve as the driving mechanism for the air-starting arrangement. In the case of a six-cylinder engine there are three- air-starting valves operated by such rollers, two for the three-and-four-cylinder engines, and a single valve for the one- and two-cylinder engines.

Fig. 5 gives an idea of the driving mechanism for these pumps and how they are controlled by the governor. Each of the plunger pumps has a constant stroke with a displacement in excess of that required for maximum load. Each pump also has a separate suction-control valve, all of which are operated by a single cam on the governor shaft, as previously explained.

The auxiliary fuel pump draws its supply through a suction check valve, and the plunger of this pump then forces the oil through another check into the reservoir. This pump maintains a constant level of fuel oil in the reservoir. Through an overflow pipe, any excess in the reservoir or seepage of oil into the lower chamber, where the valve springs are located, is drained back into the auxiliary fuel-supply tank.

The injection cam is fixed in relation to the crankshaft, and as the high point, or nose, rotates toward the injection-pump rocker roller, the injection-pump plunger moves upward. Owing to the fact that the suction valve is open, the fuel oil passes back to the reservoir. The governor cam also rotates, and when a depression in the face of this cam is reached, the suction valve closes, so that pressure begins to build up rapidly in the injection-pump cylinder. This pressure overcomes the action of the spring holding down the discharge valve, and the fuel oil passes out to the injection nozzle at the cylinder, which is also lightly spring loaded.

Dribbling Avoided

Continuing in its upward stroke, the fuel-pump plunger comes in contact with and opens the relief valve, permitting the oil to pass directly back to the reservoir. As a result of the opening of this relief valve, the injection pressure in the fuel line is reduced instantly to zero, and the fuel injection at the cylinder is cut off sharply, so that the length of the injection line has no effect on the amount of fuel injected and there is no dribbling at the nozzle.

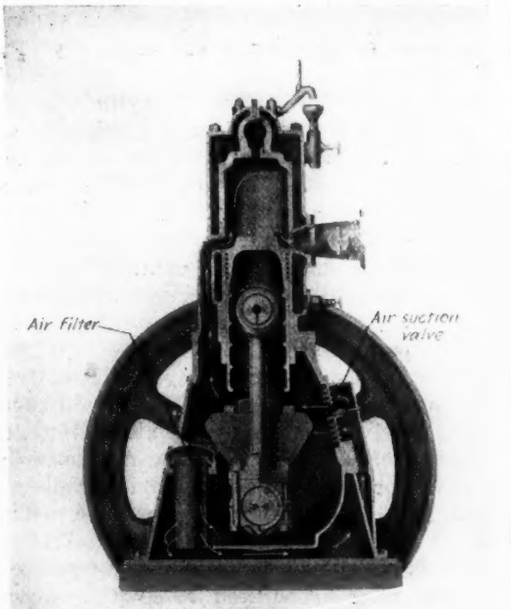
As was previously mentioned, the injection cam is fixed in relation to the crankshaft, but it is possible to change the adjustment of this cam by loosening the three nuts shown on the governor hub in Fig. 5. This hub is marked in degrees, and whenever it is desired to change the timing of the fuel injection, the cam is rotated the required number of degrees. Such an adjustment changes the timing of the injection alike on all cylinders.

The cam that controls the time of closing of the suction valves rotates freely in relation to the crankshaft and is connected to the governor mechanism through the links *M* and *N*. When the load on the engine increases and more fuel is required, the governor rotates this cam, so that the suction-control valve closes earlier, and hence more of the fuel displaced by the fuel-pump plunger is forced through the line *G*.

Pumping Control Locks

From Fig. 4 a good idea may be obtained of the arrangement of the fuel-injection and suction valves. It shows also how priming is taken care of and how the suction-control valve is locked open when the fuel-control lever is in the stop position. It will be noticed that the shaft on the fuel-control lever contains a cam-shaped projection by which it is possible to operate the fuel-pump plunger manually in order to prime the engine. As shown in this illustration, the fuel-control lever is in the running position. When the lever is thrown over into the stop position, the projection on the shaft raises the suction-control valve, so that it is not possible for the fuel pumps to inject fuel into the cylinders.

Air starting is handled by means of a lever on the opposite end from the fuel-control lever, although they are near enough together so that it is possible to oper-



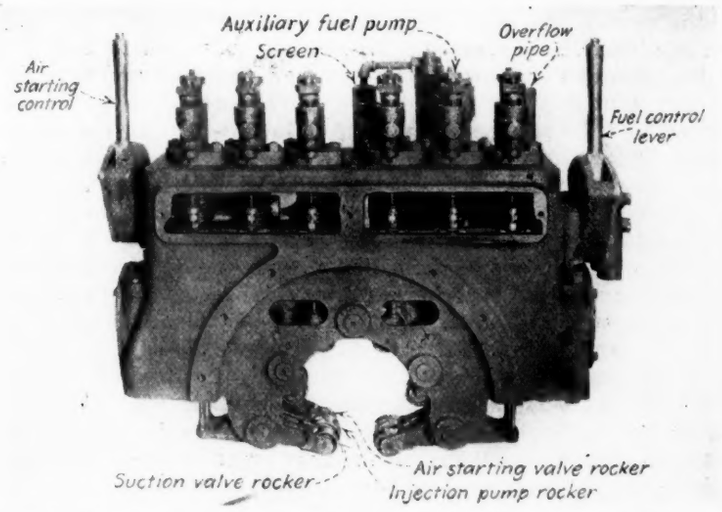


Fig. 2 (Left)—Sectional elevation. Fig. 3 (Above)—Fuel-injection pumps, forming reservoir

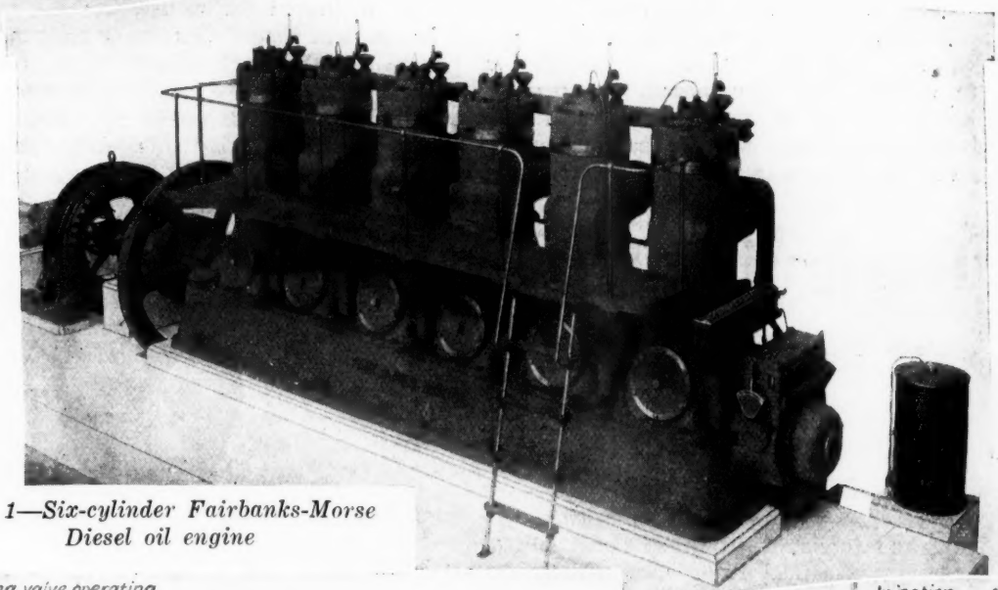
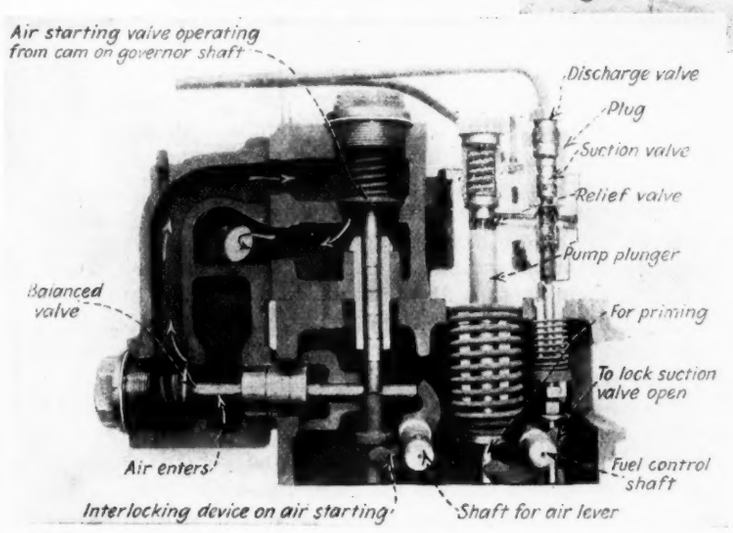


Fig. 1—Six-cylinder Fairbanks-Morse Diesel oil engine



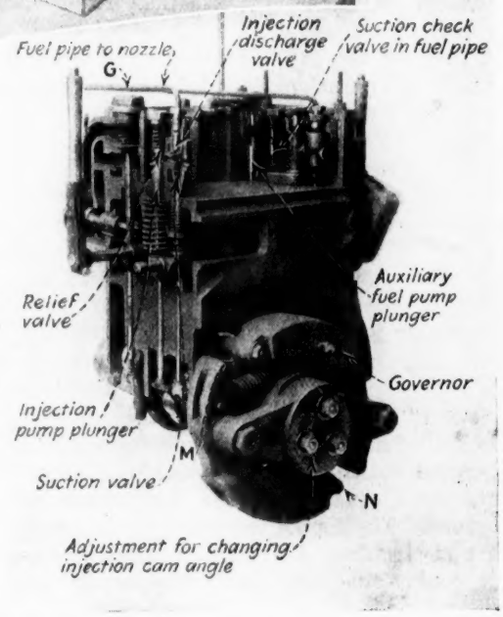


Fig. 4—Air-starting valves interlocked to prevent supercharging
Fig. 5 (Right)—View showing interrelation of fuel injection and control mechanism

ate them simultaneously. When it is desired to start up the engine, the air-starting lever is thrown to the starting side. This allows the air-starting valve roller to drop down on the cam on the governor shaft and at the same time opens a balanced valve which admits compressed air through a passageway up to the air-starting valve. The arrows in this illustration show the flow of air through the balanced valve and up to the air-starting valve.

In starting the engine, it is necessary to bar it over until the piston in one of the cylinders connected with the starting air is at upper dead center. When the air lever is thrown into the starting position, the balanced valve is opened, and since the air-starting valve already has been raised by the cam, the air flows into the cylinder and the engine turns over. The other air-starting valves then admit air to their respective cylinders when their cams lift the valves at the proper points in the cycle.

From the sectional elevation, Fig. 2, it will be seen that the fuel is sprayed into an auxiliary combustion chamber, quite similar to the former design except for certain improvements in the shape of the chamber and in the orifice leading to the cylinder. One advantage of this auxiliary combustion chamber is that the air, on the compression stroke, rushes through the neck of chamber and meets the spray from the injection nozzle. The turbulence caused aids in preparing the fuel for complete combustion and also holds the charge in suspension. For that reason it is unnecessary to use a high injection pressure or a complicated injection nozzle, the latter carrying a check valve, a spiral for breaking up the fuel and a tip with an orifice having the unusually large diameter of $\frac{5}{64}$ inch.

Cooling water is introduced into the cylinder jacket at a point near the top and also at a point near the bottom and leaves the jacket near the top of the auxiliary combustion chamber. Control valves on both top and bottom inlet connections afford close regulation of the water circulation with a view to maintaining uniform temperatures throughout the cylinder wall. A sight flow at the cooling-water outlet gives visual evidence of circulation, and a thermometer indicates the cooling-water temperature.

In the new engine the lubricating system is entirely automatic, consisting of a double lubricating-oil pump and an outside filter. The pump supplies oil to the mechanical lubricator, governor case and main bearing walls. The governor case and main bearing walls are interconnected, and the oil is maintained at a constant level in them by the lubricating pump. Used oil drains from the crankcase to the oil sump and is pumped to a two-compartment filter, separated from the engine where it is filtered for re-use.

At the present time the engine is built in sizes of $37\frac{1}{2}$ and 50 hp. for the single-cylinder unit, 75 and 100 hp. in two cylinders, 150 hp. in three cylinders, 200 hp. in four cylinders, and 300 hp. in six cylinders. Rating on a conservative basis is indicated by a mean effective pressure of approximately 30 lb. per square inch.

Poor Designing in a Refrigeration Plant

Brine Pump Suctions Not Drowned—Coils Froze Up—Double-Pipe Cooler Leaks—Ammonia Charge Lost

By ROLAND L. TULLIS

THE proper design of the refrigeration plant undoubtedly calls for a great deal of knowledge, common sense and foresight. In fact, technical knowledge without any practical experience usually proves a poor foundation.

A number of years ago I was employed by a large creamery corporation as refrigeration engineer. The compressors were twin-cylinder, single-acting, vertical machines of antique design and were direct connected to Corliss engines. They had been in operation for about fifteen years. The creamery building was four story, reinforced concrete, the main brine tank being situated on a sort of mezzanine or between the first and second floors of the building. Brine circulation was used for cooling a vast quantity of milk, also for cooling the refrigerator rooms throughout the building.

Two large motor-driven brine circulating pumps of old design were on the second floor about 15 ft. above the level of the tank from which they drew their supply of brine. The runner-shaft packing had been allowed to become old and hard or had been screwed up too tight. As a consequence the shafts were badly scored and worn. These pumps took the brine from the main tank and circulated it through a bank of about a dozen large double-pipe brine coolers before it was delivered to the milk coolers and refrigerators.

These brine pumps gave the operating engineer no end of trouble. They would often lose their suction four or five times daily, owing to the fact that air would be drawn in around the shaft, destroying the suction of the pump. When the brine circulation stopped, refrigeration was at a standstill. If the engineer was not on the alert and the pumps were not primed and started again immediately, the double-pipe cooling coils would become flooded with liquid ammonia. Owing to the absence of brine circulation the ammonia would not boil or gasify. If the trouble was not remedied soon and the brine again started to circulate, the coils would be frozen solid. These pumps were some distance from the engine room. Occasionally, they would lose their suction at night and the engineer would fail to notice it. The coils would be frozen and the brine would refuse to circulate, even after the pump was again primed and started.

There was no hot-gas connection provided for thawing or defrosting the coils. All the engineer could do was to close the expansion and return valves on the coils, and apply a steam or hot-water hose to the coils and attempt to get them thawed out as soon as possible. The superintendent wanted to know what was the matter with the refrigeration. The engineer still had more trouble ahead of him. When the coils were finally thawed out and the brine again started to circulate, he had to be very careful about the way he opened the

return valves on the coils. The coils had accumulated liquid ammonia, and if their outlet valves were opened too suddenly, a slug of liquid would go over to the compressors.

One engineer opened the valves wide and started back to the engine room. When he arrived a few minutes later, one of the 40-ton machines was minus a cylinder head and he had to don an ammonia helmet to get inside the engine room to close the suction and discharge valves on the compressor.

An alert and experienced engineer in this plant could tell without leaving the engine room when the brine pumps had lost their suction by the sudden drop of both high and low pressure on the machine and excessive frosting back on the suction. Most of the trouble in this plant was caused by lack of foresight when the plant was originally constructed. We finally eliminated all trouble with the brine pumps by simply lowering them to the same level as the brine tank so that the brine would flow by gravity into the pumps.

Another cause of serious trouble on two or three occasions was the fact that the brine pressure on the double-pipe cooling coils was greater than the ammonia pressure. The coils were installed in a dark, inaccessible place, where it was almost impossible to get at them to make repairs or keep them in proper condition. They had been in operation twenty-four hours a day 365 days in the year for practically their entire life, some fifteen years. Rust and corrosion had about destroyed them.

Brine in the Ammonia

One day the operating engineer noticed that the high- and low-pressure gages on the compressors began to drop in a sudden and mysterious manner. He naturally supposed that the brine pump had lost its suction and the brine had stopped circulating, but examination of the brine pumps showed that they were functioning properly. The pressure gage on the pumps stood at the usual point, 25 lb. The suction lines leading to the compressors were rapidly losing their frost, and the compressors began to snap and thump as if they were getting liquid of some kind; we were sure that it was not ammonia liquid, for how could one account for the sudden rise in temperature of the suction lines? All decided that it was high time to shut down the plant until the trouble was corrected.

A quick examination of the ammonia receiver showed the glass to be full. This was unusual as the system had not been pumped out, and the receiver should not have been more than half full of ammonia under these conditions. The ammonia in the glass had a dirty color, indicating that something was seriously wrong. We withdrew a sample of ammonia from the receiver and submitted it to the evaporation test. The result was more brine than ammonia; in fact, the liquid refused to boil to any extent. This accounted for the sudden drop in high and low pressure and the sudden melting of frost on the suction lines. The snapping and pounding of the compressors had been caused by the liquid brine in the cylinders. We had had leaks in double-pipe cooling coils before, and brine would always get into the ammonia, since the brine pressure was 25 lb. while the suction pressure on the coils was around 18 to 20 lb. Saving an ammonia charge in a case of this kind is usually an impossibility owing to lack of facilities for removing the brine from the ammonia.

There was such a large quantity of brine mixed in with the ammonia that its refrigerative power was destroyed and it would require too long a time to re-distill it all, even if the plant had been equipped with any kind of an ammonia regenerator.

Getting Back into Service

As is usually the case in a refrigeration plant of this kind, the greatest problem was to get the system back in operation as quickly as possible, so we decided to blow the mixture of brine and ammonia into the sewer and flush it down with water. When this was accomplished an air hose was attached to the air compressor in the engine room where 100 lb. pressure of hot dry air was available; with this we completely cleansed the ammonia system from one end to the other. Great care was used to get all the brine or moisture out of the system, for any great amount of moisture will weaken the ammonia charge and cause other troubles. The leak in the double-pipe cooling coil was finally found and repaired, but there were no auxiliarly cooling coils that could be used while the repairs were being made. Altogether, the plant was shut down for nearly twenty-four hours, entailing a great loss and a lot of inconvenience to the creamery plant.

The only advantage such a situation creates is that it usually inspires the management to some sort of action. In this case the manager lost no time in having a large shell-type brine cooler installed in the main brine tank. After this was put into operation, the double-pipe brine coolers were torn down, inspected, cleaned and thoroughly overhauled. They were put in shape and held for use in case of emergency.

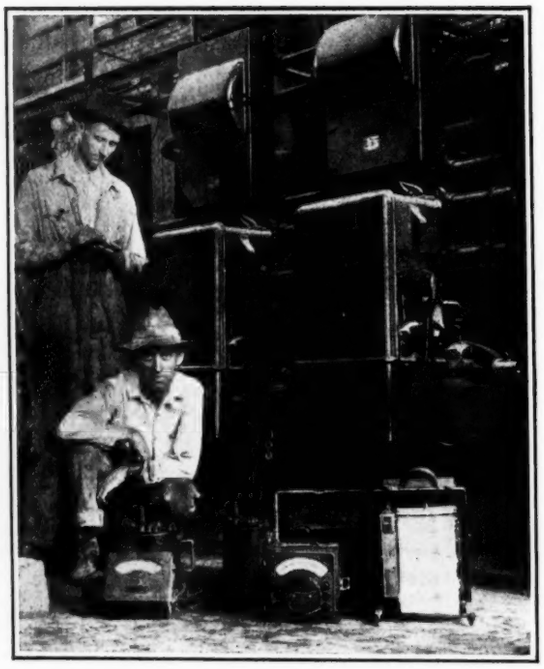
Chrome Alloy Steel

While chrome has been prominently identified with the manufacture of certain coloring pigments, its usefulness to the power-plant engineer is becoming accentuated with modern steam conditions.

Steels are improved by adding 2 or 3 per cent chromium representing a relatively low content, which gives a finer grain structure with increased strength and ductility known as "tough hardness." With a high carbon content, such as 1 to 1.5 per cent, and the addition of nickel in proportions of 1 to 3.5 per cent, it is perhaps the most useful and extensively used of all alloy steels. Nickel and chromium both tend to increase toughness and ductility. "Such steels are the only steels which will successfully meet the exacting demands of armor plate, projectiles and ordnance," says Dr. Walter M. Mitchell, in the January issue of *The Blast Furnace and Steel Plant.*

Stainless steels may contain from 10 to 15 per cent chromium, the carbon varying around 0.15 to 0.40 per cent. The greatest resistance to corrosion is obtained after quenching around 1,700 to 1,800 deg. F. Cold working results in strained conditions and increases the liability of stainless steel being attacked by corroding agents. Tensile strength of 200,000 lb. per sq.in. can sometimes be obtained by air hardening and tempering at 1,100 deg. F.

When sections of $\frac{1}{8}$ in. or less in thickness are to be joined by means of an electric-arc weld, the edges need not be beveled, but they should be separated a small amount instead.



Testing Alternating-Current Motors

By J. ELMER HOUSLEY
Electrical Engineer, Aluminum Company of America, Alcoa, Tenn.

Kinds of Tests To Be Made—Instrument To Use in Making Tests—Use of Meters and Securing of Data—Working Up Test Data—Methods of Making Motor Connections So That Tests Can Be Made with the Least Interference to Operation.

ALTERNATING-CURRENT induction motor tests may be divided into two classes, individual motor tests and feeder or group tests. In making motor tests it is well to have a clear idea of what constitutes good performance and to find out by means of a motor test whether faulty performance is caused by the driven machine or by circuit conditions. The latter should be examined first for voltage, frequency, power factor and for balanced load on each phase. A possible variation of 10 per cent above and 10 per cent below normal voltage is the maximum to be tolerated without serious detriment to motor operation.

Low voltage is sometimes the cause of overheating of the motor at full load or less. The circuit frequency should be held within limits of 5 per cent above or below normal. Such a variation in frequency affects the production output of a machine more seriously than it affects other characteristics of the motor. The circuit frequency determines the no-load speed of the motors, and the full-load speed is lower by the amount of the slip of the motor. The latter varies from 5 per cent to 8 per cent in standard squirrel-cage motors and is almost proportional to the load. If the motor speed at no load is 900 r.p.m. and the full-load speed is 855 r.p.m., the slip is $\frac{(900 - 855) \times 100}{900} = 5$ per cent.

A decrease in speed below normal indicates some trouble in the rotor, which may be loose rivets in end rings, defective brazing or broken slot insulation (where wound rotors are used). For such loose connections the best permanent remedy is to silver solder the rotor bars to the end rings.

The next condition to examine is the power factor of the motor. The power factor may vary from 15 per cent at no load to about 90 per cent at full load on the moderate-sized motors. With a motor operating at 80 per cent power factor—usually considered a good average—the losses due to heating in conductors, transformers and generators is more than 50 per cent greater than at 100 per cent power factor. The inductive effect of this lagging current in transformers and generators is more serious than that of the useful current, and the voltage regulation of the system is made much worse.

The last condition to be checked is the balancing of load on different phases, and this may be found to be caused by several coils cut out of a motor, or a motor

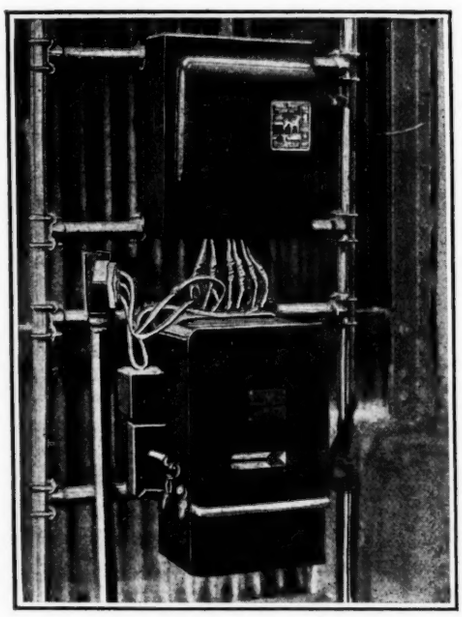


Fig. 1—Method of connecting compensator and switches with sleeve connectors, for easy connection of test leads or quickly changing equipment.

with one fuse blown. The latter condition may escape casual observation when the motor is not fully loaded, as the motor-starting taps are usually connected ahead of the main fuses.

Group tests are usually made with the prime object of determining the feeder circuit and transformer group loading, power factor, voltage and balancing of load in phases. Where a plant is of considerable size, there will usually be several transformer banks at different load centers, and often the feeder circuits from these centers are metered with a watt-hour meter. The test should include a recording-wattmeter test with voltage and current readings taken on each phase. Often motors will be added to a feeder circuit until the circuit and transformer are overloaded, and a test at regular intervals will indicate when the capacity of the equipment is reached. Instances have come to the writer's attention where transformers were burned out from this reason.

The assortment of meters required for these tests varies with the size of the plant. For the small plant with limited funds available for testing work, the simplest equipment would include an ammeter with a special split-type current transformer of sufficient capacity to measure the current of the largest motor. Below 500 amperes this equipment must be used as a unit since the ammeter is calibrated with the transformer and leads. The equipment should also include a good voltmeter with two ranges, one for lighting circuits and one for power circuits. These meters will only tell whether the voltage is normal and whether the motor is overloaded or not. No indication of power may be obtained owing to the wide variation of the power factor of the motor.

One application of these meters is illustrated by a recent use of a 125-ampere ammeter. A condenser circulating-water pump motor rated at 200 hp. 2,200 volts had been under observation because of hot bearings. The current transformer was slipped over one of the motor leads while the motor was running. The meter read 60 amperes. The full load amperes as shown on the name-plate was 48. The condenser suction valve on the jet condenser was closed a few turns until the amperes dropped to about 48 and no further trouble with bearings occurred.

For proper motor testing the following list of meters is suggested as the minimum for any power house or industrial plant, and the cost should not exceed $400.

Two portable current transformers with primary taps for 25 to 100 amperes and 5-ampere secondary.

Two portable current transformers having 1,000-amperes primary and 5-ampere secondary. These should be of the through type to slip on the cable and be wound for a range between 100 and 1,000 amperes on the primary.

One voltmeter, indicating, two ranges, say, 0-150 and 0-300 volts with multiplier to give range of 0-600 volts where necessary.

One electro-dynamometer ammeter of the indicating type with a scale for 0 to 5 amperes.

One wattmeter of the polyphase recording, strip-chart type with device to change speed of chart from inches per hour to inches per minute.

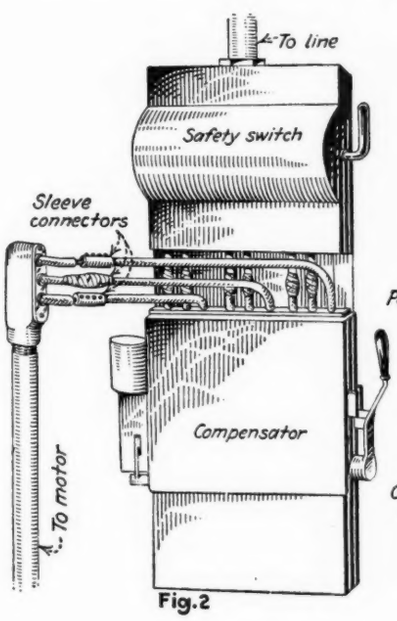


Fig.2

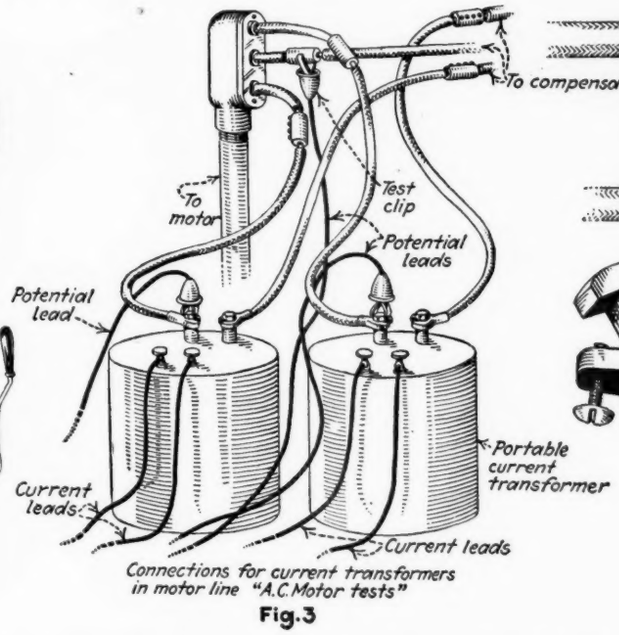


Fig.3

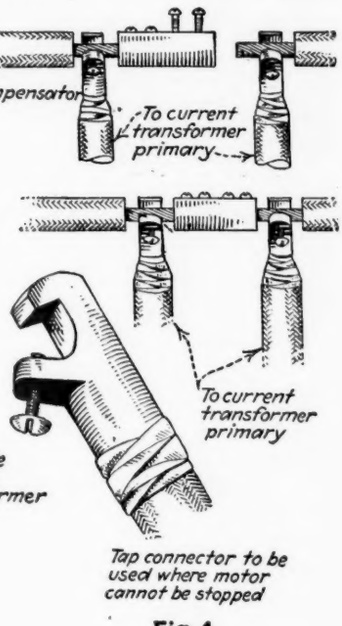


Fig.4

Figs. 2 to 4—Show how connectors are used for easy connection of test equipment

The strip-chart wattmeter is the most desirable type for motor tests as it gives a clear legible record for any type of intermittent load by varying the chart speed so as to spread out the record and prevent overlapping of the fluctuations of the pen.

Two observers should be used on motor tests in order to secure simultaneous readings of the wattmeter, ammeter and voltmeter. At the peak and minimum load the amperes and volts should be marked on the strip-chart so as to tie the record in with the observed readings noted on the test record sheet. Every chart should be marked at the beginning of the test with the date, name of drive, building number, current-transformer ratio and the hour when the test was started and ended. The omission of these data causes much confusion when the charts are worked up. It is often desirable to use a calibration curve for the wattmeter to correct the actual readings for scale variations when writing up the tests. The zero setting should not be changed between calibrating tests. The recording of the data obtained on the tests should follow that outlined in the article, "Testing Direct-Current Motors," Jan. 20 issue. It is important to secure sufficient

data for properly interpreting the results of the test at any future date. Neglect of this point is a common fault of many motor tests. All data which are taken in notebooks should be transcribed and written up on the final data sheet on the day of the test where possible, as quite often missing information may be recalled while the test is fresh in mind The data sheets may be numbered and the strip-charts given the same number. The most convenient method of filing strip-charts is to roll them up and fasten each end by means of a paper clip to a 4x6 index card, a card holding about five charts, which then may be assembled in a card index drawer.

Other Instruments for Large Plants

For large plants a number of instruments other than those already mentioned may be desirable, such as a recording power-factor meter, recording voltmeter, megger, frequency meter, tachometer and others.

Some production machinery has a definite load or duty cycle which is repeated at regular intervals, and

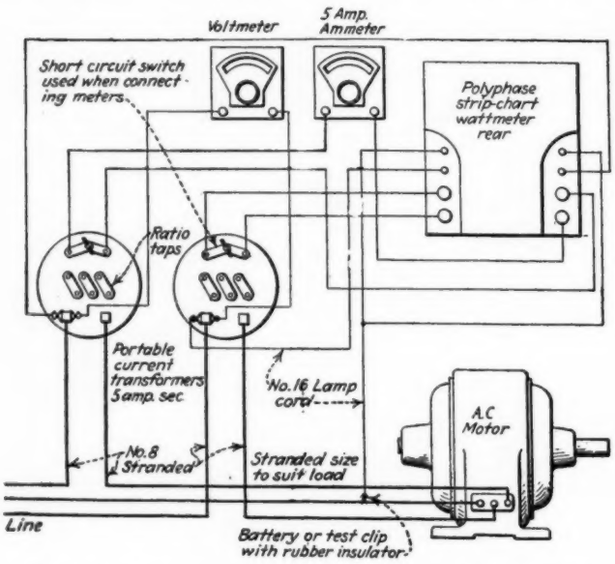


Fig. 5—Diagram of meter connections for testing alternating-current motors

such equipment requires regular tests on the motor drive in order to determine if the power is being used economically, that changes in production schedule have not overloaded the motor and that the kind of material has not changed and caused overloading. Such a condition on pumps was mentioned in Dec. 2, 1924, *Power*. In making alternating-current motor tests the following data should be obtained:

Temperature—The temperature of the stator iron may be taken by a glass-bulb thermometer and the air temperature should be noted. This is done to insure that the full-load temperature does not exceed 40 deg. C. rise above an ambient or air temperature of 40 deg. C. The permissible full-load rating must be reduced until the actual observed temperature of the motor is about 80 deg. C. Where a multiple-circuit winding is used in the motor, a too high temperature at full load or less may mean that one of the winding circuits is open.

Speed—A hand revolution counter and a watch with a second hand form the cheapest and most nearly foolproof means of taking motor speeds. The speed must be taken to guard against rotor troubles, low or high frequency or possibly low voltage and to check rated production output in some cases.

Amperes—The indicating ammeter should be connected into each phase at some time during test in order to check against single-phase operation, "dead" sections of winding (cutout coils) and balancing of load on phases. Single-phase operation is hard to distinguish owing to the motor generating a voltage in the open phase.

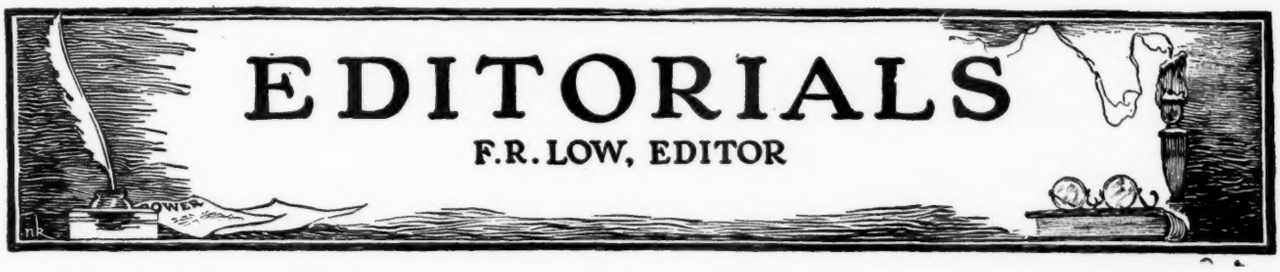
Voltage—Reading of volts should be made across each phase some time during the test to check against single-phase operation, high-resistance joints (causing unbalanced voltage) and overloading of one phase by single-phase transformers. The phase giving about average voltage should be used for test readings.

Kilowatts—The power in kilowatts should be read from each half of the polyphase recording wattmeter at the beginning of the test by short-circuiting one current transformer and detaching one of its secondary leads. The load on the motor should be high enough to insure a power factor of over 50 per cent; then each half of the load will give a positive reading. At any load, when steady enough, each half of the meter may be read singly and the ratio of the two readings may be applied to a sine curve to obtain the power factor. Power factor may also be calculated as subsequently shown.

Kilovolt-Amperes—The kilovolt-amperes may be calculated from the voltmeter and ammeter readings. This value is interesting as it shows the apparent power consumed. Transformer banks and alternators are rated in kilovolt-amperes in order that the power factor for each load need not be stated to indicate their rating.

Power Factor—Power factor is the ratio of actual power in kilowatts to the apparent power in kilovolt-amperes, or power factor $= \frac{\text{kilowatts}}{\text{kilovolt-amperes.}}$ Other data common to all tests were given in a previous article on, "Direct-Current Motor Tests."

In making tests they may be arranged to interfere not at all with production processes. In the beginning a standard method of splicing connections to compensator and motor should be adopted so that the leads of the testing equipment will fit every motor. One very satisfactory way is to make all connections at this point with brass sleeve connectors with screws to clamp the conductors, which are slipped into each end of the sleeve as in Fig. 2. Stranded conductors must be sweated where they go into the sleeves. One test lead of each of the two pairs from the current transformers may have a sleeve attached. The motor connections may be untaped while running, and a shutdown of five minutes will serve to open the sleeve connections and insert the test leads as in Fig. 3. Where this short interruption is undesirable, the insulation of the conductors on each side of the sleeve may be cut back and a clamp-type connector may be secured to the conductors, Fig. 4, and the sleeve connection opened without interruption to the drive. Such live work applies only to circuits of 550 volts and lower. Sufficient insulation is provided by using a dry foot board and careful manipulation is essential. All temporary connections should be taped to prevent short-circuits. The secondary of all current transformers must be short-circuited unless the meters are connected in circuit, as considerable voltage is obtained across the secondary terminals on open circuit with current flowing in primary.



The Giant Power Report

FOR the last year and a half a board of engineers, at the direction of Governor Pinchot, has been making a study of the power situation in Pennsylvania. Its report, built upon the idea of what the Governor chooses to call "Giant Power" as distinguished from "Superpower," has just been rendered and submitted to the General Assembly.

Recognizing the part that power plays in our industrial organization and as a factor in the American standard of living, the basic idea is to make power available to everybody as cheaply as possible and, by extending it to rural districts and small communities, to decentralize rather than centralize industry.

To render this possible, it is proposed to create a common pool into which power from all sources will be poured and out of which power for all uses is to be taken. Great mine-mouth power plants are to be laid down, and a system of common carrier transmission lines are to deliver this current to "mutual electric companies" and "rural electric districts" which would handle the distribution. A Giant Power Board is to designate all plant locations and transmission routes.

Governor Pinchot is apprehensive of a growing power monopoly, which may make for good or evil, and believes that his plan of Giant Power is the one way to protect the rights of the people and at the same time insure a fair return on the capital invested. Moreover, he believes that it will counteract the public-ownership idea and as such should receive the hearty co-operation of the private companies. While his sincerity of purpose is unquestioned, the adaptability of the plan remains to be proved. Owing to its somewhat startling proposals it will no doubt be the center of much controversy and may have to be modified in some respects in order to be applicable to existing conditions and to receive the support of private capital and the power companies which he invites.

Pulsations and Combustion

THE instant combustion starts on the surface of a solid piece of fuel, whether it be a large lump on a grate or a suspended particle of pulverized coal, the surface is immediately veiled or "polarized" by a film of carbon dioxide. This must be swept away, or at least diluted, by new air before combustion can continue.

In a uniform fire, with a steady current of air passing through, the scrubbing action is vigorous in some of the vertical passages. In others it is less thorough. Combustion is still slower in the horizontal passages, the horizontal surfaces being practically smothered in their own combustion products. At first there might seem to be no remedy for this condition, but experiments now in progress in Great Britain and Europe indicate that combustion may be greatly improved by arranging for a pulsating supply of air. With the pulses of increased pressure air is forced into the dead spaces—in small amount, it is true—while with each pulse of lowered pressure some dead gas is removed. The result is more rapid and uniform combustion, according to J. Deschamps, writing in the February 6 issue of *The Engineer*.

An interesting possibility mentioned by Mr. Deschamps is that the intelligent application of pulsating flow to pulverized-fuel furnaces may lead to more rapid combustion and a shorter flame. In this field the pulsations would have to be much more rapid than with grate firing to be of value, since the particles of pulverized coal float along with the air and have but a small inertia in proportion to the force exerted by the relative movement of air and particle. In other words, the back-and-forth movement of the air with respect to its average forward velocity would have to be so "jerky" that the coal particle could not follow the motion. Only a displacement of the particle relative to the gas stream would be required to scrape off its envelope of CO_2.

The amount and frequency of the pulsations for the best results is a matter to be determined by experience. Laboratory experiments have already shown a marked shortening of the pulverized-coal flame with pulsations of certain frequencies. The results of experiments on a practical scale will be awaited with much interest by combustion engineers.

Engineering Versus Commercialism

WITHIN the last ten years there has been much discussion as to the position of the engineer in modern times. It has been suggested that since so many of the leading problems in government are engineering, the engineer must fit himself to take his place in the administration of public affairs. He should be able to stand on his feet and argue his case with the trained lawyer. His training should include those qualifications that would fit him to become an executive in a large business establishment. He should be able to evaluate the commercial possibilities of a project or piece of equipment as well as the engineering problems involved. And so on, these requirements and qualifications might be extended almost indefinitely.

It is doubtful if anyone has a clear conception of what the engineer's position in modern affairs should be, but since engineering has become so closely woven into the fabric of modern civilization, his must be an important part. He must have a proper commercial perspective of new developments and be able to ascertain and solve the engineering problems. There is apparently a resentment on the part of some in our engineering organizations against members' giving an unbiased expression on commercial problems, even though these organizations are supposed not to be influenced commercially.

Only recently, at a convention of one of the national engineering societies the president, when the commercial possibilities of a device were brought into the discussion, took an attitude that practically eliminated the expression of opinion on this side of the question. If the engineer cannot discuss the broader commercial applications of his problems, with due regard to professional ethics, in a meeting of his own organization, with men of his own chosen profession, where are such problems to be considered?

Advancement in any art is not alone the discovery of some new principle or the development of a new piece of equipment, but also its commercial application. It is of little use to go to great expense to produce a machine for doing work that can be done better by something that is already in existence, or if the new equipment is too expensive to compete commercially with other apparatus already available. Therefore, the engineer should have a proper vision of the commercial possibilities of the developments upon which he may advise his company to venture. There should be some place, if he so desires, where a full discussion of these problems can be had. This place would logically seem to be in the meetings of his own organization; if not, then his professional society is not being allowed to function to the best interest of those qualifications there has been so much talk about the engineer possessing.

Deaeration in the Small Power Plant

THAT corrosion troubles in feed-water piping, economizers and boilers can be prevented by deaëration of the feed water, was first demonstrated only a few years ago. One of the earliest processes consisted of heating the water to a high temperature and allowing it to spray into a chamber at a lower pressure. A certain amount of the heated water flashed into steam, and this flashing led to the removal of the entrained air and gases. The heat in the flashed vapor is recovered, and although there is a slight drop in feed-water temperature, no appreciable heat loss results. Later, processes were developed in which the air is removed from the heated water either through violent agitation by steam bubbles or by a form of film evaporation. The drop in feed-water temperature is almost negligible in such cases.

Air and gases may be removed from feed water effectively by either of these two systems and, once removed, do not enter any other power-plant apparatus.

It is said that appreciably higher vacuum has been noted when deaërators are in service than when out of service. This is due no doubt to the fact that the steam entering the condenser is air free and high vacuum is therefore possible.

Condensers have been modified lately so that they can act as effective deaërators of their own condensate, and some excellent performances have been reported. This would seem satisfactory so long as a closed system of feed-water heating is employed. Makeup water is frequently injected into the condenser and deaërated therein, although there has been some question as to whether the air thereby introduced does not exert a certain blanketing effect on the tubes. This would be more noticeable in the small plant where the percentage of makeup may be large. The economy of this procedure will be wholly dependent on the value attached to the slight drop of vacuum that may occur as a result.

There are undoubtedly a large number of small power plants whose economy might be improved and operating difficulties lessened by furnishing the boilers with oxygen-free feed water. Separate deaërators of the first two types may or may not be difficult to work into the system. In other cases it may be easier to modify the condenser baffling or the air-pump arrangement so that the condensate may be effectively deaërated. Additional steam-jet air pumps might be used if necessary. A great deal of difficulty with corroded parts both in the water system and the steam system might thereby be avoided by suitable deaëration of the feed water. Care must be taken that such water is not again exposed to the atmosphere in a later stage in the feed system, or otherwise it will reabsorb oxygen with great rapidity and the benefits of deaëration will be wholly lost.

Recipe for a Low Fuel Bill

WHAT are the essential over-all conditions that must be maintained to insure a minimum fuel bill in the industrial plant using heat and power? They may be boiled down to a simple "recipe" that will have meaning to the plant superintendent as well as to the engineer, and enable the two to work in closer harmony in the business of producing dividends.

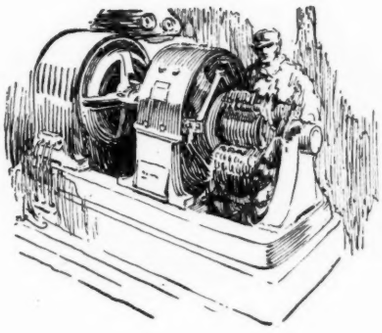
First, secure as high a boiler output as possible, measured in B.t.u., per dollar spent for fuel. This does not necessarily mean buying the coal that costs least per million B.t.u. Nor does it necessarily mean buying the fuel that will burn with the highest efficiency. It does mean buying the fuel that will give a maximum value to the product of the boiler efficiency by the heat units bought for a dollar.

Second, if heat (other than heat in the flue gas, which has already been taken care of under boiler efficiency) is blowing to waste from the plant, either in excess exhaust or in condensing water, cut this loss to a minimum. With non-condensing operation, excess exhaust may be reduced by the use of more efficient main units, by lowering the back pressure, by increasing the initial pressure and superheat, by stage feed heating and by the electrification of auxiliaries. With condensing operation the heat loss in the discharged circulating water may be reduced by better vacuum, by reducing bleeder pressures, by the use of more efficient units, by increasing the steam pressure and superheat, by stage feed heating and by the electrification of auxiliaries.

Third, if there is not enough exhaust steam for heating and process, whether this be at the start or after carrying out the changes just mentioned, cut down process steam consumption by studying processes and by charging departments for the steam used, and cut down heating steam by improved control of heating apparatus and the elimination of such conditions as the leaving of windows open to counteract the effect of overheated radiators.

The second and third processes can, in imagination at least, be applied alternately. When the economy campaign begins, exhaust may be blowing to waste. Engine-room improvements may be carried to the point where considerable live steam will have to be supplied to process and heating. Then, intensive effort may again reduce process and heating consumption to a point where further improvements in engine-room economy will be worth while. It is like making a snowball. You pat it first on one side and then on another until it is as small and well-balanced as possible.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. Three prominent operating engineers have been invited to act as judges. The winners for January will be announced next month.

Keep the Spare Unit Ready

Plant executives often accept day-in-and-day-out service from the power plant as a matter of course. They are sometimes prone to neglect spare equipment in favor of the sweetly running machine that acts as though it would go on forever. They save the hundred or more dollars that would put the spare machine in working condition, and then the breakdown costs them ten times that much.

Our engine-room generating equipment consisted of two engines, each direct connected to a direct-current generator of about 75 kw. capacity. The No. 1 unit was used alone for carrying the load. It had run for years with little trouble and could handle a heavy load. The No. 2 unit had been bought second hand for use as a spare, and some amateur repairing had not improved its operation. It was not available for use.

The breakdown came on Sunday morning, when some special experimental work was being carried out. Direct current was needed to run a centrifugal pump, so it was necessary to run the engine; lights were turned on all over the shop to give the engine a small load.

The experiment was nearly finished, when all of a sudden the engine let go, the cylinder-head being hurled against the wall some distance away. The engineer had passed the end of the cylinder only a second before, but he escaped injury and was able to shut the steam off before the engine was wrecked.

At first it looked as though the water discharged from the experimental equipment into a sump had backed up into the engine and had been directly responsible for the smash. Later examination indicated, however, that a fracture had developed in the connecting-rod strap and had spread until it finally gave way.

Here was a pretty mess. Sunday noon; the engine broken down, with pieces scattered all over the room; orders going through the shop promised for delivery within the next week; the spare engine down; and no prospect of putting either engine in working order for at least two weeks. Luckily, the damage was confined to the engine itself. The flywheel, shaft and generator were not touched.

We got the shop executive on the job immediately. Then things began to happen. A large plant close by but on the opposite side of the railroad generated both direct and alternating current. If they could give us a direct-current feed to our switchboard, we would be able to operate until the engine could be repaired. We phoned the factory superintendent and then his chief engineer. They were perfectly willing to help us out, but found that such technical difficulties as stringing lines across tracks made it impossible.

There was only one chance left. If we could get a 220-volt alternating-current power line run into the plant by the public utility company, and could get a suitable motor, we might be able to belt the motor to the engine flywheel, thus motor-driving our direct-current generator.

We phoned a large dealer in second-hand motors, and found that he could supply a motor suitable for our work. We arranged to have this motor delivered the following day.

The public-utility company agreed to install transformers on a pole opposite the plant, and run a temporary 220-volt alternating-current power line into the engine room, all at actual cost to them.

We phoned to the engine factory and were put in touch with one of the executives, to whom we explained the accident and the amount of the damage. He promised to have a service man at our plant on the following day to find out just what parts would be needed.

The next morning we kept as many workmen as were needed for preparing the motor foundations (in the meantime we had gotten the necessary dimensions on the motor) and as many as could work without machinery, and sent the rest home. We were able to light the shop through an outside 110-volt line which was always used after working hours.

We arranged to get a pulley for the motor and a leather belt. The foundation bolts were ready for the motor by the time it arrived, and it was put in place at once. The engine room was cleaned up, and all reciprocating parts were disconnected from the flywheel shaft.

By the time the electrical work was finished, everything else had been attended to, and on Wednesday morning the plant started up full again. Of course there were minor starting troubles, but these were soon ironed out. The plant operated this way for about a month. Little trouble was experienced, and the engine service man was able to make a thorough repair job.

Had it not been for the energetic and rather unusual solution of this problem, the cost of closing down the plant would have amounted to a considerable figure. As it was, the total cost of the breakdown was about $5,000. Of course, the moral is: *Don't believe in perpetual motion; keep the spare equipment ready for use.*

North Glenside, Pa. W. J. RISLEY, JR.

Effect of Indicator Motion on Oil-Engine Diagrams

Since most capable steam-engine operating engineers are familiar with the use of the indicator and the method of its employment on the steam engine, they may be led to believe that its application to the oil

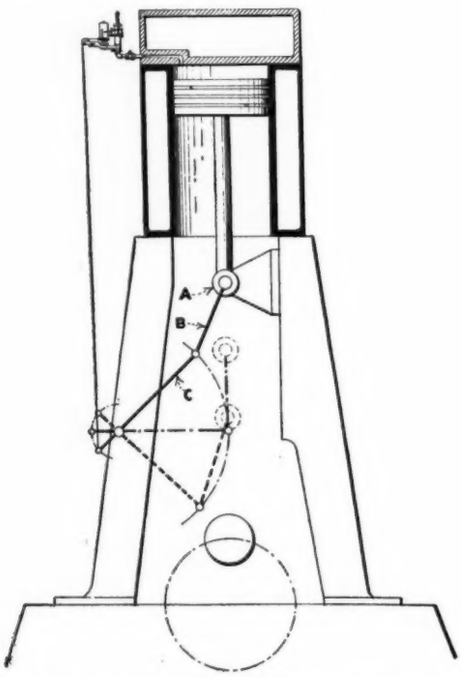


Fig. 1—Typical indicator motion

engine is of the same importance and of a similar nature.

This is true to a certain extent, but in my opinion, the indicator is more essential to the oil engine than to any other type of prime mover. For this reason its use becomes a matter of every-day practice and should

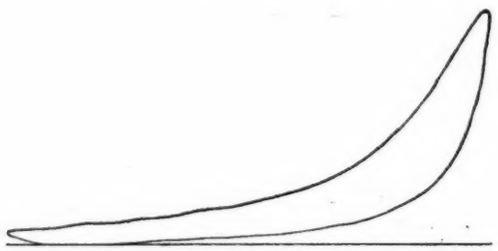


Fig. 2—Diagram obtained with type of motion shown in Fig. 1

be understood by all engineers who propose to take up the operation of oil engines.

The greatest pressure, heat and stresses immediately follow the start of combustion which takes place on the top center. Without the use of the indicator there is no practical method of knowing what these may be. It is therefore essential that the diagram be a true indication of the pressures at this point.

Fuel-injection timing may be accomplished to a close approximation by methods other than the use of the indicator, but it must be checked while the engine is in operation, and it is essential that this be done with a fine degree of accuracy. Any error in the indicator reducing-motion mechanism may lead to a wrong timing and bring about undue stresses as the result of bad combustion or excessive pressures.

The indicator makes it possible to make a comprehensive study of the pressures, and therefore temperatures and heat stresses, which have been among the greatest problems confronting the builder of all types of internal-combustion engines.

The practical operating engineer does not need to dig into this subject deeply, for experiments on the

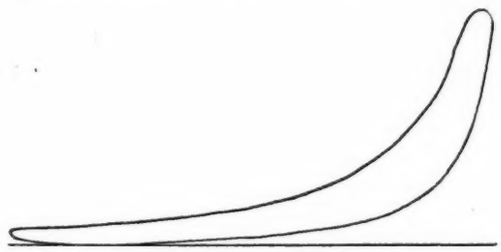


Fig. 3—Diagram obtained with type of motion having no appreciable error

test floor and in practice have developed an ideal condition of combustion revealed on diagrams such as must be the objective of every oil-engine operator who would keep his engine working well with a minimum of repair and a maximum of efficiency.

A condition may exist making it appear on the diagram that the engine works unsatisfactorily when there is nothing wrong. Since we are entirely dependent upon the indicator to tell what is going on within the cylinder, we must be sure that the mechanism that operates it be without error as far as it is humanly possible to devise.

A perfect indicator action is one that causes the drum of the indicator to move so as to give, on a smaller scale, an exact reproduction of the motion of the piston.

Fig. 1 shows a common type of steam-engine indicator motion that is sometimes used on oil engines. This type has an error that will affect the diagram, giving a wrong impression of the condition of combustion. The

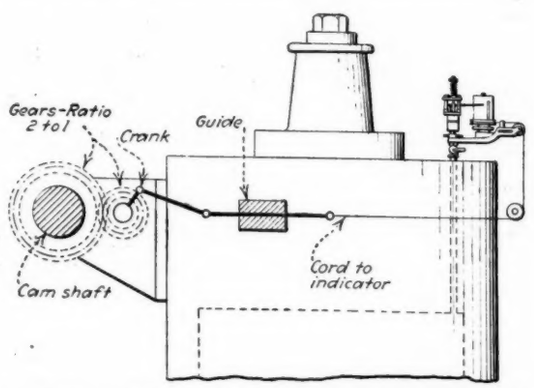


Fig. 4—Improved type of motion driven from camshaft

error is greatest when this motion is used on engines of a long stroke which have a limited space in which to house the link *B* and lever *C*, making it necessary that they be comparatively short.

In position *A* the link *B* and lever *C* are approaching a point where their centers will lie on a straight line. Practical design forbids a condition in which the cen-

ters of the link and lever would lie in a straight line. However, they are approaching this point as soon as they pass the point at which their centers lie at an angle of 90 deg. For this reason the greatest error naturally exists when the piston is at the extreme ends of its travel, and the upper end, at which combustion starts, is a most essential point.

The diagrams shown in Figs. 2 and 3 have been

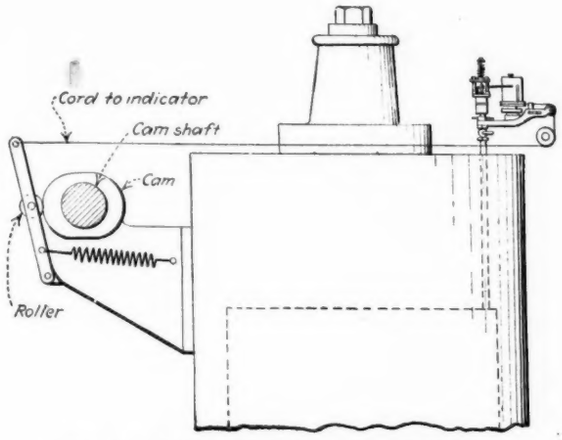


Fig. 5—Type of motion giving minimum amount of error

traced from actual diagrams taken from the same engine and the same cylinder and under the same conditions of operation, the only change made being in the indicator motion.

Fig. 2 was taken with an indicator motion similar to the one illustrated in Fig. 1. It gave the impression that fuel was slow in entering the cylinder after combustion started and that a constant pressure was not being maintained at the beginning of the stroke. Upon changing to a motion with no appreciable amount of error, the diagram shown in Fig. 3 was obtained. The experiment was tried a number of times on one cylinder and then on all cylinders with the same result. The repetitions were made with a view to proving that the difference in the diagrams was not due to any sudden change in the quality of combustion, which is sometimes the case, but by no means likely to occur repeatedly and always in the same way.

The engine design has much to do with the type of indicator motion used, and for this reason it may be necessary to employ one such as is shown in Fig. 1, in which even the existing error should always be taken into account when checking up the engine with the diagrams.

It has been my experience that more reliable diagrams are obtained by employing a motion similar to that shown in Figs. 4 and 5.

The motion, Fig. 4, is attached to the engine at a point as close to the indicator cocks as possible while being driven from the camshaft, with gear wheels having a two to one ratio, on a four-stroke-cycle engine. The same mechanism may be employed on a two-stroke-cycle engine with a set of one to one gears, or the crank may be supplanted with an eccentric attached directly to the camshaft.

The feature that makes the action shown in Fig. 4 free of error, is the fact that the ratio of the length of the link to the crank is the same as the ratio of the connecting-rod length to the throw of the main crank, thereby making an exact reproduction of the motions of the main reciprocating parts of the engine, on a smaller scale.

The motion shown in Fig. 5 is, in my opinion, as nearly perfect as any yet designed. It consists of a double cam on the camshaft of a four-stroke-cycle engine or a single cam on a two-stroke-cycle engine, driving a rocker arm to which the indicator cord is attached. The perfection of this motion depends wholly upon the shape of the cam, which must reproduce the motion of the main piston, taking into consideration the error of the rocker arm.

The limited nature of this writing does not permit the complete discussion of all types of indicator motions. It is intended to stimulate interest in the question of error, which is very important in connection with oil-engine operation.

R. C. SHOOK.

Philadelphia, Pa.

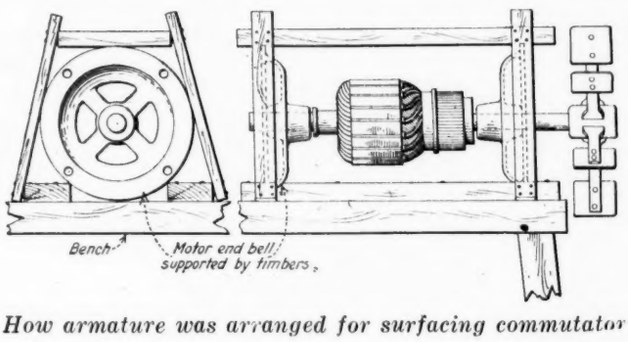
Driving the Armature with Compressor Air While Surfacing the Commutator

Recently, I was given the job of overhauling a small commutator type of motor used to drive a fan, the fan being mounted on the armature shaft extension.

On dismantling the motor I found it very dirty and the brushes and commutator in bad condition. As no spare brushes were in stock, new ones were made from some discarded carbon brushes of a larger size. I knew it was useless to fit the brushes to the commutator in its present condition, but no lathe was available and the motor could not be spared long enough to send the armature out, so some other means of surfacing the commutator had to be found.

After some planning I struck upon the idea of using the fan to drive the armature by letting a jet of air from the compressed-air line impinge upon it.

The armature was mounted on the work bench as shown in the illustration. The end bells were put on the shaft, reversed from their normal position and the fan was mounted on the end of the shaft. The



How armature was arranged for surfacing commutator

assembly was placed between two parallel strips on the work bench and fastened in place.

The nozzle of the air hose was fastened to the bench, so the air on leaving the nozzle would strike the fan and cause the armature to rotate. Grinding down the end of a file for a turning tool and fitting a block for a tool rest, completed the preparations. After taking a roughing cut with the file, the commutator was finished and polished with fine sandpaper. Then the mica was undercut slightly and the motor assembled. In this way a satisfactory job was obtained.

Struthers, Ohio. JOHN V. EMERY.

Stop the Waste

Employing a man and paying him thirty dollars a week to save fifteen dollars worth of coal after it falls through the grates and mixes with the ash, may seem, to many readers of *Power*, not an economical thing to do. Yet a case of this kind was worked out recently at a plant in which I am interested, and although it cost more to get the coal out of the ashes than the recovered fuel was worth, the wisdom of the practice was proved by the rigid system of economy that followed.

Everybody in the fireroom was anxious to save, it soon became a habit, it spread through the plant and extended to all departments. The little wastes were stopped, thereby preventing the big ones. This system of economy created a better feeling among the employees and allowed harmony to prevail where chaos had ruled before.

The intrinsic value of the coal recovered in many cases may not be worth the time spent in salvaging it, but we should bear in mind that for every pound of coal that is burned a draft is drawn on the Bank of Nature in which we can make no deposits.

New Bedford, Mass. R. G. SPOONER.

Improvised Oil Cooling Systems

Some time ago we had considerable trouble caused by heating of the bearings on our small turbine, and although we used a good quality of engine oil mixed with cylinder oil, it was impossible to keep the bearings cool enough for twenty-four hour runs, and the turbine had to be shut down simply to allow the bearings to cool.

When the bearings and oil had cooled, the quantity of cylinder oil that had been mixed in caused the mixture to be so thick that the oil rings would not revolve with the shaft, so the oil had to be replaced in part with "thin" oil until the bearing became sufficiently warm to allow cylinder oil to be used.

In an attempt to remedy this trouble, we made an oil cooler and connected it in the oiling system as illustrated in Fig. 1. The body of the cooler was made from a piece of 12-in. pipe with caps on each end.

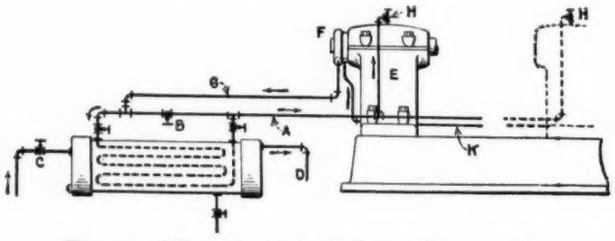


Fig. 1—Oil cooler inserted in oiling system of small turbine

A few turns of pipe were placed inside, as indicated by the dotted lines and connected through valves to the line *A* with a bypass valve *B* inserted between the connections. The cooling water is admitted to the cooler through the valve *C* and leaves through the pipe *D* to the hotwell.

The oil supply for the machine is contained in a well in the bearing pedestal *E*, and the oil is pumped through the cooler to the bearings by the small centrifugal pump *F* on the end of the shaft, the amount supplied to each bearing being regulated by the valve *H*. The oil returns from the second bearing to the oil well through the pipe *K*. Since the cooler was put into service we have had no trouble with the bearings, and it has not been necessary to use any cylinder oil or to shut down to allow the bearings to cool.

The illustration Fig. 2 shows an improvised filter and cooler used with a forced-feed oiling system on reciprocating engines. A 500-gal. tank was divided into two compartments forming the filter section *A* and the storage and cooling section *B*. The oil used on the engines returns to the filter through the line *C* and passes down through a central pipe to the bottom of

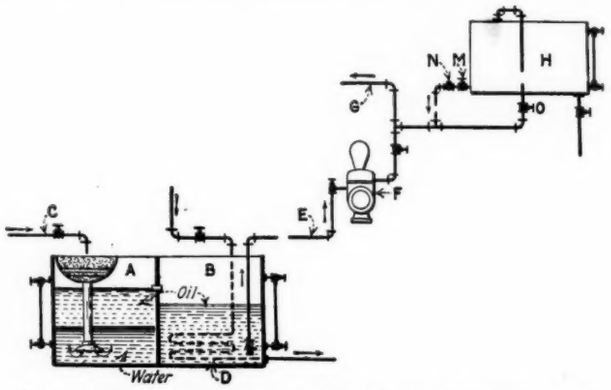


Fig. 2—Arrangement of oil filter and storage tanks in forced-feed systems

the filter and returns through the water to the oil space. From the filter the oil overflows to the compartment *B*, where it is cooled by passing over the coil *D* through which water is circulated and finally discharged to the hotwell. The oil is taken from the cooler by the pump *F* through the pipe *E*, which has a foot valve and strainer, and discharged directly to engine distributing pipes at 15 lb. pressure, the pressure being kept constant by a pump governor. To insure a supply of oil to the engine in the event of the oil pump failing, a storage tank *H* is located near the ceiling and connected to the regular supply line through a globe and check valve *M* and *N*. If the pressure on the main oil line *G* falls below a certain value, oil from the tank keeps the bearings on the engines supplied until the regular service is restored or the engines shut down. The valve *O* is opened only when it is necessary to fill the tank.

There are undoubtedly isolated plants, in which a high-grade oil is being used in order to keep the bearings at a safe temperature, in which a cheaper oil could be used if a cooler of some kind was provided. It is advisable, if possible, to use condensate or makeup water as cooling water. In this way the heat absorbed by the water in passing through the cooler is recovered.

It must be borne in mind, however, that bearings and oil must not be too cold, as a shaft and babbitt, when in service, sometimes take on a polished surface which repels cold oil on the first starting of the engine. For this reason the oil should have a temperature above 70 deg. It is a good plan, whenever possible, to circulate the oil through the engine bearings for some time before the engine is started. If the oil is cold, as in some plants in the winter months, the cooling water should be shut off and the oil circulated through the bearings before starting the engine, until sufficient heat has been absorbed by the oil in passing over the warm guides to make it flow freely. R. A. CULTRA.

Cambridge, Mass.

Comments from Readers

Direction of Flow in Sand Filters

Referring to the question of direction of flow in sand filters, as raised on page 188 of the Feb. 3 issue by L. Sanderson, the normal direction during regular operation is ordinarily from the top down. I have operated such filters in both directions, and have found that when operating from the bottom up it is very essential that the filter beds are not disarranged so that the sand is not carried over. CLAUDE C. BROWN.

Los Angeles, Calif.

Tests of Vibration in Turbine Disks

In the issue of Feb. 3 it is stated in a footnote on page 193 that the article on "Tests of Vibration in Turbine Disks" is published because the types of vibration there illustrated were not obtained in the tests described by Wilfred Campbell in his A.S.M.E. paper of last May. The types shown in your illustrations are the umbrella type, consisting of vibration about the central ring of support, the cartwheel type consisting of combined ring and radial nodes, and the 2-node type described in your present abstract as vibration about 1-nodal diameter.

All these types of vibration are noted in Campbell's paper in paragraphs 38 and 39, the latter reading: "Many other types of vibration exist, including concentric ring nodes and combinations of ring and radial nodes." Sand picture photographs of all these types were available, but gave place to more important subjects. The 2-node type having a single nodal diameter was mentioned repeatedly throughout the paper and discussed at length in paragraphs 220 to 231.

ARTHUR L. KIMBALL, JR., ERNEST L. ROBINSON,
(Co-authors with Mr. Campbell, deceased).

Schenectady, N. Y.

What Caused the Exciter To Be Overloaded?

As I understand Pierre T. Willit's question of Dec. 23, 1924, "What Caused the Exciter To Be Overloaded?" the slip-ring wires and exciter wires were in the same conduit. I am inclined to believe that the trouble with the exciter is where the four burned places equally spaced around the commutator were found, and an examination of these segments will show either a ground or a loose connection. The latter will act as a partial open-circuit, which will be noticeable only on the heavier loads or when heated. This defect would be found at the commutator neck, or at the rear-end connections of the coil when two-piece coils are used, or where the risers are riveted to the commutator segments. These connections are very deceiving to the eye and one would hardly believe that such a good joint would cause the exciter to spark. This trouble would cause the whole commutator to heat, making it appear overloaded.

To make sure that the exciter was overloaded, take an ammeter reading at the switchboard and one at the exciter and compare the two; then it can be seen what the exciter is really doing. HARRY J. ACHEE.

Woodward, Okla.

Running the "Rotor-Ship" Without Fuel-Consuming Auxiliaries

I have read with interest your excellent article (Dec. 30, 1924) on the Flettner "rotor-ship," which develops some 1,000 total horsepower from the wind, when its revolving cylinders are rotated by 11-kw. motors.

Has anyone suggested that such a rotor-ship, once started, can presumably be operated *wholly* by wind power and *without any fuel consumption whatever*, by simply arranging a small waterwheel generator to be driven by the motion of the ship through the water, the electrical output of this generator to be fed to the motors operating the rotor-cylinders?

Of course this elimination of the fuel-consuming engine now supplying power to the motors would be done at the expense of the total available navigating power developed to operate the ship. But to offset this, the rotor cylinders could be increased 10 per cent or so in size, at little extra expense, giving the same navigating power as before, but without any fuel consumption, after the vessel had been gotten under way.

Bronxville, N. Y. O. H. CALDWELL.

Electrically Driven Auxiliaries in the Industrial Plant

The editorial on electrically driven auxiliaries in the industrial plant (Jan. 20 issue) is very well put, but there is one consideration not mentioned, that is of considerable importance at times, favoring the use of motor-driven auxiliaries as far as possible throughout the power plant.

Unlike central stations, an industrial power plant may be required at very short notice to change radically the nature of its output owing to a change in product of the factory or new developments of the process, so that what has previously been a very satisfactory balance of power requirements and low-pressure steam is changed to a considerable deficiency of power and surplus of exhaust from auxiliaries, working uneconomical operation or a considerable expense to rectify it.

It is always possible to supply the desired amount of low-pressure steam by reducing valves or bleeding of main units, though where the size of the plant warrants, the latest tendency, and I believe the most satisfactory, is to install one straight condensing unit and one non-condensing and regulate the amount of low-pressure steam by interchanging the load. An interesting development along this line is the new power plant of the Bryant Paper Co. at Kalamazoo, Mich., in which a twin

unaflow engine has separate valve adjustment on the two sides, one of which runs condensing and one at 20 lb. back pressure so as to provide just the desired quantity of low-pressure steam.

The relative cost of steam- and motor-driven auxiliaries varies so with the type and other conditions that about the only true general statement would be that electrically driven auxiliaries of equal reliability can be obtained at no greater expense. Where alternating current is available, the upkeep and attendance of the electrical apparatus is less and on the direct current no greater than with steam-turbine drive and both less than with reciprocating-engine drive.

Even where steam-driven units are desirable on account of the demand for exhaust steam and flexibility of control, it pays to install the most economical type consistent with reliability, for not only is such apparatus usually better built, requiring less maintenance, but no one can tell when he will be able to reduce our exhaust-steam requirements this low or lower. For instance, many paper-board bills are replacing the twin slide-valve engines (with throttling governors) used for driving the variable-speed shafts with the most modern high-speed valve gear Corliss types so as to bring the amount of exhaust steam down to what can be used in the driers. It does not take a very considerable saving of this sort to provide handsome returns on the investment, for where one considers that with coal at $5 a gross ton a steam engine consumes on a 20 lb. per hp. hour water rate $15 worth of fuel per year for a 10-hour day and $36 for a 24-hour day, it is worth putting a little more into the original investment as insurance against such losses or the possibility of replacement of the whole equipment.

New Haven, Conn. H. D. FISHER.

Testing Insulation of Generators

Testing generator insulation in some plants is the subject of much debate, in others it receives no attention. A recent article in *Power* takes up the subject, considering only the method of testing with a high voltage. There is no doubt in my mind that high-voltage tests are injurious to old machines and will often break down insulation that would have held up for many months under normal conditions.

A much safer plan is to measure the resistance of the insulation periodically. This can be done with a voltage much below the normal operating of the machine. There is no strain on the insulation whatever, and weak spots can in this way be detected long before the machine gets to the point of failure. It is not necessary to break the insulation down to learn that it is getting weak.

Where 500- or 600-volt direct-current is available, the insulation test can be made with an ordinary voltmeter of high resistance, as in the figure. To do this with the machine shut down and all leads disconnected or near-by switches open, connect one side of the 500-volt direct-current to the frame of the machine to be tested, or if the source of current is a street-railway supply which already has one side grounded and the frame of the machine to be tested is grounded, this is sufficient. The other side of the 500-volt supply should now be connected to the voltmeter and from the other terminal of the voltmeter to a terminal of the machine to be tested. This test is easily applied, and the reading of the voltmeter is a direct indication of the resistance of the insulation of the machine. The calculation is by the formula,

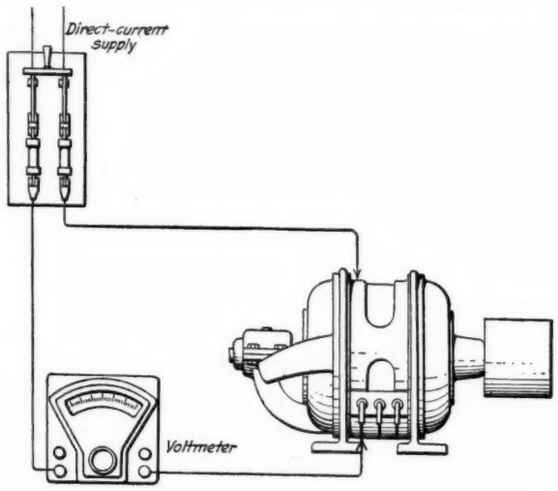
$$R = \frac{X(Y - V)}{V}$$

where R is the resistance of insulation in ohms, X the resistance of voltmeter in ohms, Y the voltage of direct-current supply and V the reading of voltmeter.

The minimum safe resistance for generator insulation is specified by the A. I. E. E. standards as follows:

$$Megohms = \frac{Rated\ terminal\ voltage}{Kva.\ rating + 1{,}000}$$

Thus a 6,250-kva. 2,300-volt generator should test not less than $\frac{2{,}300}{6{,}250 + 1{,}000} = 0.3$ megohm, or 300,000 ohms resistance. New machines will be found to have



Connections for measuring machine insulation on an undergrounded system

many times this resistance, 50 to 60 megohms, some so high that satisfactory measurement cannot be made. In time, however, the insulation resistance begins to decrease, and I believe this always occurs before the machine fails, and may ordinarily be discovered before the development of any trouble except that due to lightning or other unexpected abnormal strain.

R. E. THOMPSON, Power Supt.,
Springfield, Mo. Springfield Gas & Electric Co.

Boiler-Feed Explanations and Calculations

We note in paragraph 5, page 113 of the Jan. 20 issue, a printer's error in the second line, which should read: "We have made practical demonstrations of lifts in handling cold water of over 30 ft., etc." instead of 20 ft. as printed. Thus the article will correspond with the curve that accompanies it.

The last last sentence in paragraph 2, page 112, is perhaps not entirely clear, and would be better with a slight addition which would change this sentence to read as follows: "It should be definitely understood that the entrance of liquid to the pumping element is in all cases due to pressure existing at the inlet sufficient to overcome the pressure existing at, and losses incident to, actual entrance to the pumping element."

E. F. DOTY and M. M. KLOSSON,
Engineering Department,
N. Tonawanda, N. Y. Buffalo Steam Pump Co.

Questions and Answers

Conducted by

Franklin Van Winkle

Effect of Increasing Counterweight of Flyball Governor

When an engine is equipped with a flyball governor, how is the speed affected from increasing the counterweight, and what would be the effect of increasing the weight of the flyballs? *J. P. K.*

By increasing the counterweight, more centrifugal force is required to raise the governor to obtain the point of cutoff which will balance the load, and consequently the engine would be governed at a higher speed. Conversely, if part of the counterweight is removed or the weight of the governor balls is increased, less speed is required to create the necessary centrifugal force for raising the governor to the point of cutoff for which the load will be balanced and the speed of the engine will be reduced.

Slip Frequency as Applied to Alternating-Current Motors

In applying speed-regulating sets to induction motors, I have noticed the term "slip frequency" used. What is the difference between slip frequency and the line frequency? *R. O. A.*

Slip frequency is the number of cycles per second made by the current in the rotor of an induction motor. If the rotor of an induction motor is brought up to synchronous speed—that is, to the same speed as the revolving magnetic field of the stator—the voltage and frequency in the rotor become zero. To accomplish this power must be applied to the rotor, since, normally, the rotor must run slower than the stator's magnetic field to generate a current in the secondary winding of a value to produce sufficient current and torque to carry the load. At full load the rotor will run from 5 to 10 per cent slower than the stator's magnetic field. This difference in the two speeds is called the slip of the motor, and the frequency of the current in the rotor is called the slip frequency and is in proportion to the rotor's slip. If the rotor is running 10 per cent slower than the stator's magnetic field and the line frequency is 60 cycles, the frequency of the rotor's current is $60 \times 0.1 = 6$ cycles per second, and this would be referred to as the slip frequency. At 50 per cent slip the slip frequency of the current in the rotor would be 0.5 of the line frequency. If the rotor is locked so that it cannot turn, the frequency of the current in this winding will be the same as that of the line, in which case the slip frequency is the same as the line frequency.

Where regulating sets are applied to controlling the speed of induction motors, the rotor's speed may be above or below synchronism. When the rotor is running above synchronous it is said to have a positive slip, and when running below synchronism the slip is said to be negative. In either case the slip frequency is equal to the difference between synchronous speed and the rotor speed times the number of poles, divided by 120. Synchronous speed of an alternating-current motor equals 120 times line frequency divided by the number of poles. If a motor has 4 poles and operates on a 60-cycle circuit, then its synchronous speed equals $120 \times 60 \div 4 = 1{,}800$ r.p.m., which is the speed of the magnetic field. If the rotor of such a motor runs at 1,700 r.p.m., the frequency of the rotor's current will be $(1{,}800 - 1{,}700) \times 4 \div 120 = 3\frac{1}{3}$ cycles, which is the slip frequency.

Knock with Engine Underloaded

The piston rings of my engine fit snugly and do not show any wear. When driving the load the engine runs smoothly, but when the engine is released of load or only driving empty machinery there is a knock in the cylinder. What would cause the noise and how can it be remedied? *C. H. D.*

A knock would occur in an automatic single-valve engine from the valve becoming raised off its seat by excessive compression when there is reduction of the load. The height of compression would be reduced by running with lower back pressure. If the knock appears to occur only once in a revolution, an indicator diagram probably would reveal unequal valve action with earlier compression in one end than the other end of the cylinder, requiring adjustment of the length of the valve stem or other connection between the valve and governor. With a four-valve engine, underloading, with cutoff so early in the stroke that expansion occurs below back pressure, would cause exhaust valves to be raised from their seats during the latter part of the admission stroke and returned with a slap or knock in the beginning of the exhaust stroke. This can be prevented by throttling the admission pressure when the engine is underloaded, so later cutoff will not result in expansion below back pressure.

Blowoff Tank for Battery of Boilers

We have eight horizontal return-tubular boilers each 72 in. in diameter by 18 ft. long for which we desire to supply a blowoff tank in place of discharging the main blowoff line over the side of a steep bank. We have a steel tank 5 ft. in diameter by 20 ft. long that could be used for the purpose. Would this be large enough and what outlets should be provided? *H. N.*

The tank is of ample size, but in selecting a location every precaution should be taken that no damage will be done in event of rupture from water hammer or excessive pressure. The tank should be provided with a manhole in the top with a light loose cover on the outside, and for escape of vapor, place in the top of the tank an open vent pipe at least twice the diameter of the inlet pipe. Connect the inlet in or near the

top of the tank and have an outlet in the bottom for cleaning, with a valve that should be closed when the tank is receiving blowoff water from the boilers.

For discharge of water, place an outlet in one of the heads of the tank 18 or 20 in. above the bottom, with inside connection dropped within 6 in. of the bottom, so the oulet may be kept sealed; or if more convenient, make this outlet 6 in. above the bottom and, to obtain a seal, connect this outlet outside of the tank with a plugged cleaning tee, and a 12-in. riser with discharge elbow.

Coal Required to Heat Given Quantity of Water

What quantity of coal would be required for generation of steam supplied to pipe coils to heat 70,000 gal. of water from 35 deg. F. to 75 deg. F.? *J. W. W.*

Taking the weight of a gallon of water as 8⅓ lb., the weight of 70,000 gal. would be 583,333 lb., and as the heat required to raise one pound from 35 to 75 deg. F. would be 40 B.t.u., the total heat required would be 583,333 × 40 = 23,333,320 B.t.u. The amount of coal required would depend on the conditions. The heat available from each pound of coal burned depends on the heat content of the coal, the combined efficiency of boiler and furnace, the temperature of boiler-feed water, the loss of heat sustained in transmitting the steam to the heating coils and loss of heat from discharge of the condensate or lost in returning the condensate to the boiler, and also loss by radiation from the water that is to be heated. For example, assume that the coal used has a heat value of 14,000 B.t.u. per pound and the boiler efficiency is 60 per cent, the heat transferred to the water in the boiler would be 14,000 × 0.60 = 8,400 B.t.u. per pound of coal, and allowing that the condensate formed in the heating coils is returned to the boiler and the total losses amount to 15 per cent, then heating of the water would require 23,333,320 ÷ [8,400 × (1 — 0.15)] = 3,267 lb. of coal.

Point of Cutoff by Slide Valve

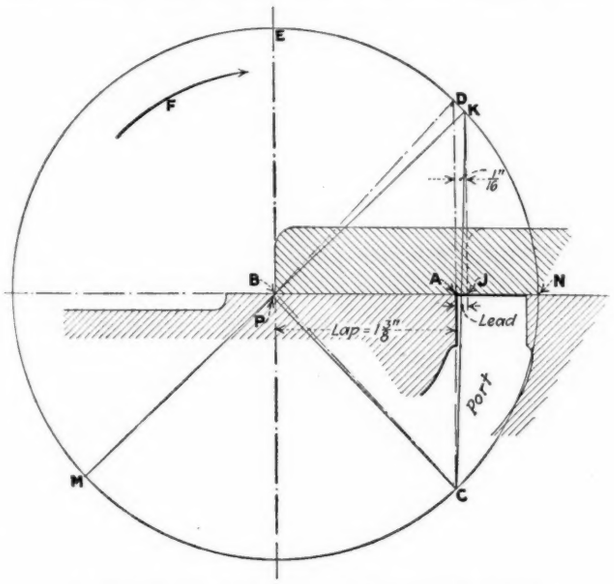
Without allowing for angularity of the connecting rod or eccentric rod, what would be the point of cutoff of a slide valve where the throw of the eccentric is 2 in., lap of valve 1⅛ in. and lead 1/16 in.? *W. H.*

The fraction of stroke at which cutoff would occur may be determined graphically as indicated in the figure. Suppose *A* is the opening edge of the part.

From *A* lay off the lap *AB* = 1⅛ in. With *B* as a center and radius = 2 in. throw, describe the circle *EKNCM* to represent the path of the center of the eccentric. Through *B* draw the center line *BE* perpendicular to *AB*, and through *A* draw the chord *CAD* perpendicular to the valve seat. Then for rotation in the direction indicated by arrow *F*, the angle *EBD* is the "lap angle," or angle through which the eccentric would have to turn to overcome the lap; that is, to carry the opening edge *B* of the valve from its central position to *A* the opening edge of the port. As the lead is 1/16 in., locate *J* as the opening edge of the valve at the beginning of the stroke and draw *JK* parallel to *AD* to find *K* position of the eccentric at the beginning of the stroke; that is, when the crank is at dead center. As the valve would begin to open when the eccentric is at *D*, it would be closed again when the eccentric arrives at *C;* but from placing the eccentric at *K* when the crank is at dead center, the total rotation from the beginning of the stroke to the time of cutoff would be while the crankshaft and eccentric are rotated through the arc *KNC*. That is to say, while rotation takes place through the angle *KBN*, the opening edge of the valve would be carried from *J* to *N*, and during rotation through the angle *NBC*, the opening edge *J* would be carried from *N* back to *A*.

Therefore the angle of rotation made by the eccentric and crankshaft from the beginning of the stroke to the time of cutoff would be *KBC*.

If the semicircle *KNCM* is taken to represent the path of the crank during one-half of a revolution and *KM* is taken as the length of stroke, then dropping the perpendicular *CP* on *KM* gives *KP* as the length of stroke accomplished up to the time that cutoff occurs.



Determining point of cutoff of slide valve

As *KM* = 4 in. and *KP* = about 2 3/32 in., the fraction of stroke accomplished from dead center up to the time of cutoff would be $\frac{PK}{KM} = \frac{2\frac{3}{32}}{4} = \frac{2.03125}{4} = 0.5078$, or practically one-half stroke.

Location of Fusible Plugs

Where should fusible plugs be placed in a Heine type and in a B. & W. type of water-tube boiler? *T. J.*

When fusible plugs are used, they should be placed at the lowest permissible water level of a boiler in the direct path of the products of combustion as near the primary combustion chamber as possible. Unless otherwise required by local laws and ordinances, in water-tube boilers of the Heine type the plug or plugs should be placed in the front course of the drum; and in B. & W. type boilers, in the upper drum, over the first pass of the products of combustion. In either type the plugs should be placed 6 in. above the bottom of the drum, projecting through the sheet not less than one inch.

[Correspondents sending is inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

The Practical Meaning of Curves

WHAT is a curve or graph? It is a line (either straight, curved or irregular) so drawn on a piece of co-ordinate paper as to show how two

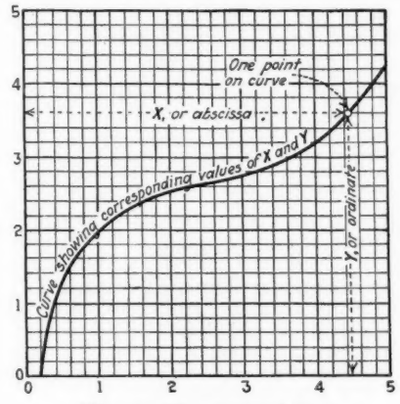


Fig. 1—The general case

mutually dependent quantities vary together. The general case is illustrated by Fig. 1. Here the curve shows the corresponding values of two quantities X and Y. The X distances (measured horizontally) are called abscissas and the Y distances (measured vertically) are called ordinates. This curve shows than when Y equals 2, X equals 1.02, that when X equals 4, Y equals 3.2, etc.

Fig. 2 shows a definite application. The circumference of a shaft (or of any circle) is always 3.1416 times the

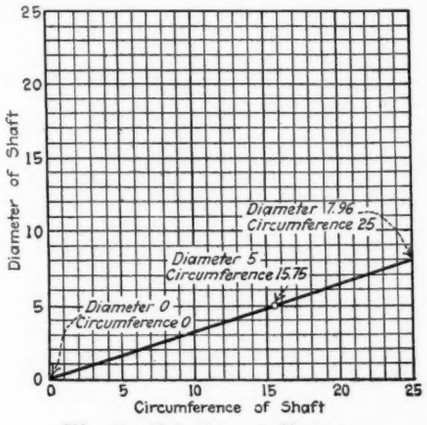


Fig. 2—Relation of diameter and circumference

diameter. Lay off scales as shown for diameter and circumference. Then figure a few points on the curve. When the diameter is zero, the circumference is also zero. When the circumference is 25, the diameter is 7.96. This gives the two ends of the curve. Take any other diameter, say 5, and figure the corresponding circumference, in this case 15.75. If this point is plotted, it will lie on a straight line with the other two.

In fact, when one quantity is directly proportional to the other, the "curve" is always a straight line passing through the "origin," as the zero-zero point is called. To draw such a curve it is only necessary to figure one pair of values and draw a straight line from the origin through the plotted point.

Sometimes one quantity is not directly proportional to the other, but the *increase* is proportional. This likewise gives a straight line, but one that does not pass through the origin. Fig. 3 is such a curve, giving the relation between the total weight, including water, of a 180-lb. tank and the gallons of water contained. The left end is located at once from the fact that the empty tank weighs 180 lb. It is only necessary to figure one other point to

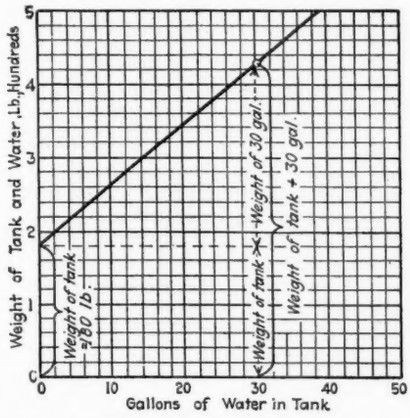

Weight of Tank and Water, Lb., Hundreds
Weight of tank = 180 lb.
Weight of tank + Weight of 30 gal.
Weight of 30 gal.
Weight of tank + 30 gal.
Gallons of Water in Tank

Fig. 3—Total weight of 180-lb. tank containing water

locate the straight-line curve. Take thirty gallons. This much water will weigh $30 \times 8\frac{1}{3} = 250$ lb., giving a total weight of 430 for water and tank. The straight line is then drawn through these two plotted points.

The area of a circle does not increase in direct proportion to the diameter, but rather as the square of the diameter. Here it is necessary to figure and plot enough points to permit drawing a smooth curve through them. In Fig. 4 points were figured for diameters of zero, 10, 20, 30, 40 and 50. This type of curve, where one quantity varies as the square of the other, is called a parabola.

Another type of curve, illustrated by Fig. 5, is obtained where one quantity is inversely proportional to the other. This is true of the volume of a cubic foot of air at constant temperature. If the pressure is doubled, the volume is cut in half, etc. It is only necessary to plot one point on such a curve. The rest of the curve can be located by geometrical construction. It is known that at a 14.7 lb. absolute pressure and 60 deg. F., the volume of one pound of air is 13.14 cu.ft. This gives one point. Through this point

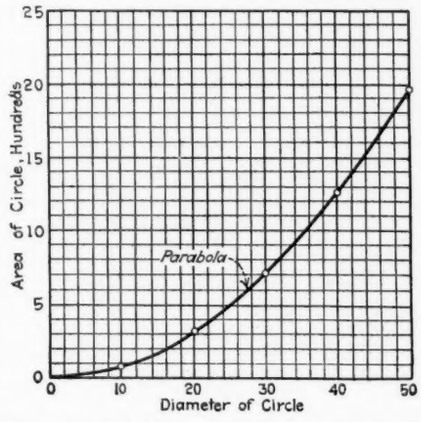


Fig. 4—Relation of diameter and area

construct a hyperbola in the manner indicated by the dotted lines. First draw a vertical and a horizontal line through the point. Next draw a series of radial lines at random from the origin. Take these lines as the diagonals of rectangles having two adjacent sides lying in the original horizontal and vertical lines. Complete the rectangles. All the corners opposite the first point will lie on the curve, making the plotting of the curve a simple matter.

Every engineer should have a stock

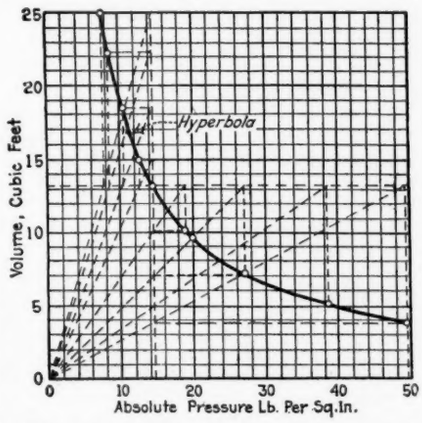


Fig. 5—Weight of one pound of air at 60 deg. F.

of co-ordinate paper on hand. This can be obtained in a great variety of forms. For ordinary rough work letter-size paper ruled ten lines to the inch is convenient and cheap. Finer graduations are obtainable for close work.

Combustion Control*

By T. A. Peebles
Chief Engineer, Hagan Corporation

Roughly speaking, there are two results to be secured with a system of combustion control: First, the proper proportioning of fuel and air, and second, the variation of the fuel and air quantities in proportion to the load requirements.

Air for combustion is supplied by a fan or chimney, and the quantity is controlled by adjusting one or more dampers or controlling the speed of the draft fan. It is easy to control either of these elements, but difficult to do it in such a manner that the quantity of air being supplied will bear the correct relation to the quantity of fuel. In the case of chimney draft regulated by a boiler damper, the weight of air drawn in will vary for a given position of the damper with changing atmospheric and temperature conditions and with any condition existing within the boiler setting itself that may affect the draft loss or temperature at which the gases leave the boiler.

The Problem Is Complicated

When it comes to considering the supply of coal, many factors are introduced to complicate the problem. It is not difficult to establish a relation between stoker speed and quantity of air being supplied, but this will not insure the proper air-fuel ratio. If the stoker hoppers are kept filled and there is nothing to interfere with the free flow of coal to the feeding mechanism of the stoker, the volume of coal fed will bear a fairly close relation to the stoker speed. The percentage of fines in the coal, however, will affect the weight per cubic foot, and even if the stoker puts in the correct number of cubic feet, it will not necessarily put in the correct weight. Furthermore, coal that is free from surface moisture will not give the same results as coal containing surface moisture. Ordinarily, screenings will weigh from 5 to 10 per cent less per cubic foot when containing 5 per cent surface moisture than when free of such moisture, so that there will be a difference of perhaps 10 per cent in the actual weight of fuel delivered for a given stoker speed, assuming that the coal is all of the same general quality and carries the same B.t.u. per pound dry.

Under conditions of varying size and surface moisture of the coal, a definite relation between stoker speed and weight of air supplied for combustion will not necessarily maintain the correct air-fuel ratio. Something more elaborate than the control of stoker speed in accordance with air supply is necessary if the equipment is going to be entirely automatic.

A change in the quality of the coal will produce a change in the fuel-bed condition, which will not become apparent immediately, but will eventually produce unfavorable conditions if allowed to continue. The quantity of fuel in a furnace at any given time permits of short periods when the coal supply is not in proper relation to the air supply, without producing unfavorable conditions, but in case these periods should be of long duration, it requires the attention of a capable operator to make such adjustments as may be necessary to the stoker speed to re-establish the correct relation.

A correction might be applied in accordance with variations in the CO_2 content of the gases leaving the boiler or by the relation of air flow to steam flow. Neither of these arrangements is entirely satisfactory because the quantity of coal in the furnace does not necessarily determine whether proper contact is being secured between the fuel and the air supplied for combustion. For example, the CO_2 might be low not because there is insufficient fuel in the furnace, but because the fuel bed is irregular or there are clinker accumulations along the side walls or the grate surface itself. The remedy is, of course, not to supply additional fuel to the furnace, but remove the clinker formation.

In spite of the limitations that prevent control equipment from replacing the stoker operator, it can be of great assistance to him, and if the relation of one to the other is thoroughly appreciated and the work divided as it should be, a substantial improvement in over-all results is to be expected.

Steam Pressure Should Be Maintained Uniform

It is desirable that the steam pressure be maintained uniform within a few pounds, and the adjustments necessary to accomplish this end are made more satisfactorily by automatic means than by hand. Where the load is at all irregular, a large part of the fireman's time is consumed watching the pressure gage and adjustments of air supply. A master regulator, operating in accordance with changes in the header pressure, can be utilized to vary the air supply and the coal supply simultaneously, or it can vary the air supply alone and let a second automatic unit adjust the stoker speed in accordance with the change in air supply. If these adjustments are made in proportion to the change in header pressure, the steam pressure is automatically maintained within the desired limits, provided, of course, that the equipment in service is not overloaded and that the fuel beds are kept in proper condition.

This simultaneous regulation, under ideal conditions, would maintain a uniform fuel bed, but the various factors encountered in stoker operation will require a certain amount of attention on the part of the operator. Since he has been relieved of all work except that of keeping the fuel beds in proper condition, he has ample opportunity to observe any departure from desirable conditions and make the necessary corrections.

A properly working system of combustion control reacts favorably on many conditions apart from the actual maintenance of the air-fuel ratio and the variations in the quantity of fuel and air in accordance with load requirements. One of these factors is the feed-water control. It can be shown that the rate at which the boiler absorbs heat is affected almost instantaneously by an adjustment of air supply. The rate of heat absorption affects the circulation of water in the boiler and consequently has an effect upon the water level which in turn affects the rate at which the feed water controller puts water into the boiler.

There is a natural tendency for the superheat to change with the rating at which the boiler is operated. Since the fuel and air adjustment can be made more gradually and at the proper time by automatic means, it follows that the boilers can be kept operating more closely to the actual load requirements than can be done by any except the most careful and skilled hand operation, so that with automatic control the superheat is maintained more nearly uniform.

Other factors affected by improper regulation of the air for combustion are tube replacements, clinker formations and maintenance costs.

The Discussion

In discussing the paper, Joseph Harrington stated that there are numerous operations around the plant in which the operator cannot do so well as the regulator. He cannot judge how much the damper on the steam valve of the stoker engine should be opened to balance the requirements exactly. Almost universally the operator will overdo it, so that conditions vary from one extreme to the other. The production of CO_2 is a continuous chemical process, and if the ingredients are not added in steady proportion, good results will not be obtained. Automatic regulation, in his opinion, is one of the vital necessities to the economical production of steam from bituminous coals.

C. H. Smoot agreed that combustion was purely a chemical process, its efficiency being a question of mixture supplemented by questions of temperature, fuel beds, etc. But all through it was important that the chemical necessity of the problem be considered. This required quantity control of the air and the fuel.

The fireman has it entirely within his power to get results, good, bad and indifferent. He has a rough, dirty job, calling for backbone and determination to go through. On the other hand, he is asked, without very elaborate support and apparatus, to do a nicely balanced problem in finance, chemistry and engineering, not only once a week but every minute of the day. The greater part of the money the plant spends goes through his hands, so that it would seem a profitable investment to provide him with equipment that will facilitate his work and so improve the results obtained.

J. M. Spitzglass objected to the statement made by Mr. Peebles that the speed of the stoker did not gage the amount of coal going into the furnace, owing to variations in size and water content. With water added to the coal he pointed out that the cubic foot might have a different weight, but

*Abstract of paper read before Chicago Section of the American Society of Mechanical Engineers, Jan. 14, 1925.

the stoker passes a cubic foot of coal, and that cubic foot of coal has exactly the same combustion value as before the water was added. In other words, the dry coal will be the same. The revolutions of the stoker in combination with a given height of gate will give the quantity of combustible coal fed to the furnace, regardless of the amount of water added to the fuel. Mr. Spitzglass questioned the author as to whether the control system under discussion was the old pressure method or the new method of controlling by the velocity of the steam leaving the individual boiler. With this method there may be a dozen boilers on the line and for each the supply of air and coal can be regulated in proportion to the outgoing flow of steam.

Mr. Peeples Replies to the Discussion

In reply to the discussion Mr. Peebles assumed a certain load was to be handled by a given number of boilers. The operator puts on the number of boilers that from his knowledge of the characteristics of those units gives him the best results. Then the thing to do is to arrange the control equipment so that the load will be divided automatically among those boilers, and that can be accomplished by control from the pressure in the plant header. The change in the rate of flow of steam from the boiler will affect the pressure in the header. There is a drop through the dry pipe, the non-return valve, the superheater and the piping connections to the main header. When a plant is under banked conditions the pressures in the header and the boiler drum are equal, but when the plant begins to do work, assuming a constant pressure in the boiler drums, the pressure in the header will go down in proportion to the quantity of steam being passed from the boiler. As a consequence, the most satisfactory arrangement is a controller designed to respond primarily to pressure variations in the steam header, because it is affected both by the static pressure of the steam in the boiler drum and by the quantity of steam that is passing from the boiler. Such a system will divide the load equally between the boilers and provide for correction in the air supply to each boiler in accordance with the fuel-bed resistance. If the operator, in addition to making minor adjustments to stoker speeds, will keep the fires in the right condition, prevent clinker formations from uncovering sections of the grate surface and keep the rear ends of the stokers free from accumulations of clinker, he will get equivalent air supply, combustion and steam delivery.

Bishop Creek, Calif., Project—The Hillside Water Co. has applied to the Federal Power Commission for a license covering the project on the North and Middle forks of Bishop Creek near Bishop, in Inyo County, California. It is proposed to use for power purposes the water in four reservoirs intended primarily for irrigation, but to be utilized for power purposes at existing plants of the Nevada-California Power Co. and the Southern Sierras Power Co.

Court Annuls Day of Rest Law

By A. L. H. Street

One employed in the power plant in one industry is just as much entitled to one day of rest in the week as another employed in a similar plant in another industry. Therefore, a law which seeks to make it a criminal offense for an employer in one industry to require or permit such an employee to work more than six days a week, but exempts other industries, without sound reason for the distinction, is void. This, in substance, is what the Minnesota Supreme Court decided Jan. 2, 1925, in handing down its decision in the case of State vs. Pocock.

In 1923, the Minnesota legislature enacted a law providing that "No person shall be employed in, or about, any mechanical or mercantile establishment, factory, foundry, laundry, power plant or stationary boiler or engine room, in this state, more than six days in any one week." The following employees were exempted from the act: "Employees of railways, hospitals, telegraph and telephone companies, undertakers, cemeteries, newspapers, canning factories, potteries, sewer pipe, brick and tile factories where continuous fire is necessary, creameries, cheese factories in towns, villages and cities of the third and fourth classes, lime-burning establishments, salt refineries, places of amusement, garages, repair shops, filling stations, pharmacists, flour mills, heating plants employing but one person, etc.

Defendant, proprietor of a St. Paul hotel, was prosecuted as for violating the law by permitting one Choulsett to work "in and about the power plant, stationary boiler and engine room" of the hotel for more than six days in a week. His counsel successfully attacked the law as being violative of both the state and federal constitutions in denying equal protection of the laws to all similarly situated. The Supreme Court said:

"That the legislature may enact laws which apply only to a specified class is beyond question. But under the equality provisions of both the state and federal constitutions all similarly situated must be brought within the class and all within the class must be treated alike. . . .

"The statute in question is a sanitary measure enacted to promote the health and general welfare of employees by affording them one day of rest in each week. To be valid it must operate alike upon all who are similarly situated. If it selects particular employees of the class and gives to them privileges which it withholds from other employees of the same class; or if it selects particular employers of the class and imposes upon them burdens and restrictions from which it exempts other employers of the same class, it denies the equal protection of the laws to those discriminated against and thereby violates the constitutional mandate.

"The legislature undoubtedly may except from the operation of such a law employments and activities the suspension of which would be detrimental to the public, and also those where continuous operation is essential, or where other differences of situation, condition or resulting consequences furnish a reasonable ground for excepting them from such a restriction. But if it brings the employees of one establishment within the law and with no reasonable ground for not treating them alike, it violates the equality rule.

"An examination of this statute shows that anyone who employs men in a power plant or boiler or engine room is within the law if the heat or power generated is used in a hotel, a shoe factory, a bakery or a restaurant, but is outside the law if it is used in a newspaper plant, a place of public amusement, a cannery, a flour mill, an automobile garage, or repair shop, or a creamery or cheese factory located in a city of the third or fourth class. The need for a day of rest is the same whether the employe is generating heat and power for use in one or another of the lines of business mentioned, and the excluded employees are as clearly within the class which the law sought to benefit as are those brought within it. The statute cannot be sustained as creating a valid classification unless there are conditions or exigencies peculiar to the excluded lines of business which furnish a reasonable ground for withholding the benefit of the act from employees engaged in such lines of business, while granting it to employees performing like services in all other lines of business. No differences in conditions have been pointed out, and none occur to us, that suggest a legitimate reason for saying that employees in hotels, bakeries, restaurants, factories, packing plants, and machine repair shops shall have a day of rest, and that employees in places of amusement, newspaper plants, canneries, flour mills and automobile repair shops shall not. We know of no reason for exempting places of amusement from the operation of the law that does not apply with at least equal force to hotels which furnish accommodations for the traveling public at all times. We think the statute clearly violates both the state and federal constitutions."

New Zealand Opens Hydro Plant

With the opening recently by Mr. Massey, Prime Minister of New Zealand, of the Mangahao hydro-electric works, the greatest link in a chain supplying power to the North Island of the Dominion was put into operation. For these works there are four sources of water supply, the Mangahao itself being a little river which contributes about one-seventh of the total horsepower thus liberated. Incidentally, it is of interest that, to enable its waters to be utilized, this river was diverted toward the coast by means of two tunnels through the mountains. It is estimated that whole power available from these works will be absorbed by less than half of the island. They constitute the largest works yet completed in the Dominion, according to the *Christian Science Monitor*.

Engines of the World's Largest Motorship

THE launching and commissioning into service of the English motorship "Aorangi" has aroused unusual interest by reason of the propelling machinery. This vessel is fitted with four Sulzer Diesel engines built by the Fairfield Shipbuilding & Engineering Co., and make up the largest Diesel plant in existence.

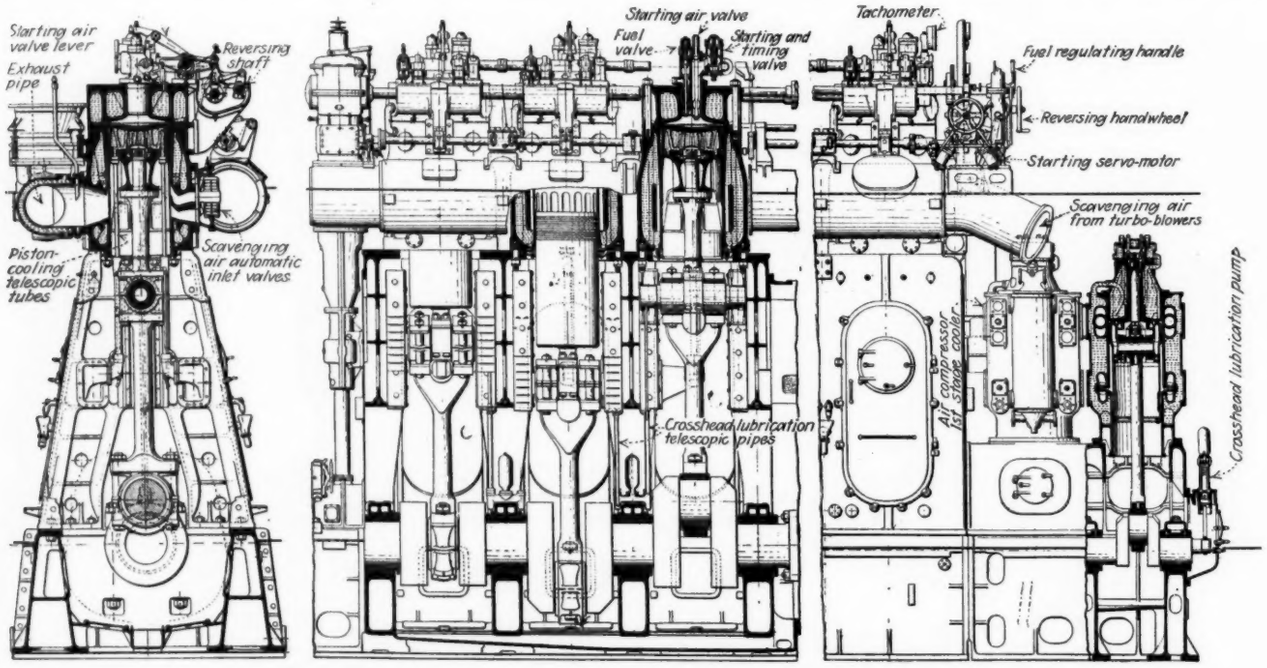
The four main engines are of six-cylinder design and operate on the two-stroke cycle. The bore is 27½ in. and the stroke 39 in., giving at 127 r.p.m. a total indicated horsepower of 17,000. The brake or shaft horsepower of the four units is approximately 13,500.

In the illustration, based on a drawing in *The Engineer*, London, is shown a cross-section through one of the cylinders as well as a fore-and-aft view of the machine. In the drawing two of the cylinders are not shown, but correspond in every particular with the others. The air compressors, there being two, are driven by a short crankshaft bolted to one end of the mainshaft. The compressor cylinders are water cooled; the intercooler tubes are straight and a set are provided for each stage. Each of the compressors is able to supply air for the engine, but the output can be increased by 10 per cent by taking the suction air from the turbo-blower delivery.

The scavenging air supply is furnished by independent turbo-blowers. On opposite sides of each engine cylinder are the scavenge-air inlet and the exhaust-gas outlet ports, while the space between the casing and the liner forms the cooling-water jacket. The scavenge ports are in duplicate, one placed directly over the other. The lower ports are uncontrolled and admit scavenging air to the cylinder as soon as they are uncovered by the piston, but automatic scavenging valves control the upper series of ports. These valves do not allow any communication to take place between the cylinder space and the scavenging air receiver on the down stroke of the piston, but on the up stroke they admit air to the cylinder and continue to do so after the lower ports have been closed by the piston. By this means a supercharging effect is obtained which, experiment has shown, greatly increases the power developed in a given size of cylinder. Five groups of six valves are fitted to each cylinder, but they are of the flat disk type and require practically no attention. This new design is a considerable improvement on the rotary scavenge valve positively driven from the vertical shaft which was fitted to earlier Sulzer-type engines.

Manoeuvring is done by means of a twin-cylinder air-operated servo-motor, arranged at the forward end of the engine, as shown at upper right in the illustration. By moving the starting lever, air is admitted to the cylinders of the servo-motor, which rotates the starting shaft, and so operates the valve levers that all six cylinders are put on starting air, while the compression release valves are held open. After the engine has been started on air, further rotation of the starting shaft puts three cylinders on fuel, the other three remaining on air, until the first three have started firing, whereupon still further movement places all the six cylinders on fuel. A marked dial, in full view of the operator controlling the manoeuvring of the engine, shows the number of cylinders on air and fuel. The action of the servo-motor is automatic, and the operation just described takes only a few seconds to complete. The progress of these operations may, however, be accelerated or retarded by the starting lever, which admits air to the servo-motor. This lever has three positions—ahead, neutral and astern.

Reversing is effected by a hand-operated wheel, which, through the medium of worm gearing, controls the swinging lever that carries the cam rollers. There are two pairs of air and fuel cams, one for ahead and one for astern, placed side by side on the camshaft. The cam rollers for the fuel and starting valves are not fastened directly on the valve rocker arms, but from this rocker arm is suspended a triangular plate carrying cam rollers, one for ahead and one for astern. To this plate is also attached the swinging lever of the reverse shaft. Upon starting the swinging lever shifts the proper cam roller to the appropriate cam, after which the engine is started in the manner just described.



Four Thousand Horsepower Sulzer Diesels for Motorship "Aorangi"

The movement back to coal from oil is gaining headway along the Atlantic seaboard, according to recent reports. A partial list of recent changes made contains the names of: Two large public utilities companies, the Eastern Massachusetts Street Railway Co. and the Narragansett Electric Lighting Co.; of many large manufacturing establishments such as Swift & Co., Jersey City plant; the Crane Co., Bridgeport plant; the Johns-Manville Co.'s Manville plant; the American Sugar Refining Co.'s Revere plant; the Androscoggin Pulp Co.'s South Windham plant; the Merrimac Chemical Co.'s Everett and Woburn plants; and the Morris & Co.'s plant at Oklahoma City. Not less noteworthy is the movement from oil to coal for heating purposes in large buildings.

Governor Pinchot Submits Giant Power Report

Provides for Mine-Mouth Plants and Common-Carrier Transmission System—Proposes More Drastic Regulation and Holds Out Promise of Cheap Power

THE Giant Power Survey Board, which has been making a study of the power situation in Pennsylvania for the past year and a half, has just submitted its report to the legislature of that state. It contains proposals for legislation aimed to establish a system of mine-mouth power plants and state-wide transmission systems operating under more drastic regulation than heretofore attempted. In his letter of transmittal, Governor Pinchot says in effect:

"Giant Power is a plan to bring cheaper and better electric service to all those who have it now and to bring good and cheap electric service to those who are still without it. It seeks the cheapest sources of power and hence the cheapest rates and proposes to create a great pool into which power from all sources will be poured and power for all uses will be taken. This is distinguished from superpower, which is the interchange of small quantities of surplus power having for its principal object profit to the companies."

Just as steam brought about the centralization of industry, a decline in country life and the decay of many small communities, so will Giant Power, in the Governor's opinion, bring about the decentralization of industry and the upbuilding of small communities.

The Governor views with concern the increasing tendency toward consolidation of electric utility companies, but believes that if effectively controlled in the public interest is can be made a great material blessing. While Giant Power takes no account of public ownership, it is his belief that co-operation of the various companies with the scheme will be the only alternative to ultimate public ownership.

The proposed legislation is summarized as follows:

1. Mass production with opportunity for byproduct recovery. This to be secured by Giant Power generating stations of great capacity in or near the coal fields, supplying large-capacity transmission lines connecting with all major transmission lines in the state.

2. The creation of a common pool of power into which current from all sources will be poured and out of which current for all uses may be taken. This is to be secured by making these Giant Power companies common purchasers of surplus power from all generating stations in the state and common sellers to all distributing systems in the state.

3. Free access by every water-power and steam generating station to every potential purchaser, which means every distributing system in the state that supplies the consumer. This is to be secured by making all major transmission lines common carriers.

4. Complete, prompt and effective regulation of rates, service and security issues. This is to be secured by fundamental changes in the Public Service Law providing for measuring a company's right to a fair return, upon the stable and easily ascertainable basis of the money invested instead of upon the costly process of valuation each time a rate is fixed.

5. Rescue of the regulation of electric service from the destruction now threatened by its conversion into interstate commerce, which would be beyond the control of the states and has not been regulated by Congress.

6. Systematic extension of service lines throughout the rural districts, this to be secured by farmers' mutual companies and by rural electric districts, each authorized to construct and operate distribution systems, and each empowered to tax and borrow money.

7. All other public-service power business would be segregated into classes; major generation (over 25,000 kw. capacity), minor generation, major transmission and distribution including minor transmission. No corporation to be allowed to do more than one of these kinds of business.

The creation of a permanent Giant Power Board to carry out the provisions of the act is suggested. This board would authorize companies to construct Giant Power plants of not less than 300,000 kw. capacity, to construct common-carrier transmission lines of not less than 110,000 volts on locations fixed by the board, and further to mine coal and sell the surplus for byproduct recovery. The board would also have the authority to issue permits for the construction and operation of these power stations for a term of fifty years.

According to *Commerce Reports* the total exports of coal from the United States during 1924 were 18,855,475 tons, a considerable reduction from 23,699,747 tons, the amount exported during 1923.

Federal Trade Commission Begins Probing G. E. Co.

The Federal Trade Commission is losing no time in beginning the investigation of the General Electric Co. which has been ordered by the United States Senate. When the resolution was delivered to the Commission on Feb. 12, a meeting of the members was called and it was decided to refer the resolution to the Commission's economic division, since the work was regarded as likely to be more of a statistical and accounting character than of a legal nature. The Commission called in its chief examiners. Schedules were arranged looking to the completion of the investigation in ample time for the Commission to have its report ready for submission to Congress Dec. 1.

Baldwin Experimenting With Diesel Locomotives

According to *The New York Times* a new type of Diesel oil-burning locomotive designed to burn the cheapest grade of crude oil and reduce the cost of fuel to between 25 and 50 per cent of the cost of coal for the present steam locomotive is being developed in the Eddystone plant of the Baldwin Locomotive Works at Philadelphia.

Mr. Vauclain, president of the Baldwin company, is reported to have said: "The Baldwin Locomotive Works is building a locomotive driven by electric motors supplied with current by an electric generator, which in turn is driven by a Diesel internal-combustion engine. The locomotive is now under construction and we expect to have it completed and ready for trial in April. This locomotive is not intended for general use or for the replacement of steam locomotives in ordinary service, but is merely being constructed to meet the requirements of special service, especially that where the railroad passes through, for long distances, a country without water, or where oil is the only fuel obtainable and in places where smoke has now become a nuisance. It could also be used for switching service of certain grades."

Mr. Vauclain said that the new engine had been developed at the Baldwin works under patents held by the Knudsen Motor Co., on a two-stroke-cycle Diesel engine of an inverted V-shape form, and under an arrangement with the Westinghouse Electric Co. for the purchase of electrical apparatus from that concern.

"The new locomotive will be more expensive than a steam locomotive to build and therefore will call for a much larger investment by the user per unit of power employed. This of course would have to be offset by the fuel economy that might be obtained by its use."

Pacific Coast A.S.M.E. Meeting Plans Announced

The committee in charge of the Pacific Coast A.S.M.E. Regional Meeting, which is to be held in Portland, Ore., from June 22 through June 25, has its plans well matured for both technical and entertainment features. A large attendance of the membership in the East who are contemplating a Western trip during the spring is desired. The National Electric Light Association will hold its annual convention in San Francisco from June 15 to 20, and an opportunity to visit the A.S.M.E. Portland meeting will be tendered them.

At the technical sessions papers will be presented on "The Utilization of Wood Waste," "The New 30-Inch Suction Diesel Dredge," "The Mechanical Engineering Features of the Long Bell Lumber Company's New Saw Mill at Longview, Wash.," "Electric Logging," "Steam Logging," "Cable Systems in Recent Logging Developments," and "The New Hydro-Electric Plant of the Portland Electric Power Co."

Banquets and entertainments have been provided as well as trips and excursions to the Oak Grove power plant, the Hog Fuel Power Plant, Longview Lumber Company's Mill, and scenic trips of unusual beauty to Mount Hood, along the Columbia River, and other points of interest.

Interlinking of California Power Companies Planned

Mr. Wilson, president of the Western Power Corp., on a recent visit to California, said that acquiring control of the Great Western Power Co. and of the San Joaquin Light & Power Corp. by his organization would give added service to the territory served, as the two systems are ideally located for interconnection and that the purchase was a natural step in the ultimate development of the properties.

"Engineering studies are being made at the present time which will determine the future power-development program. There is available one million kilowatts of potential hydro-electric power on the two systems for development during the next ten years if the growth of the state continues as it has in the past. There is sufficient installed capacity on the two systems to carry through the year 1925, but work will proceed, however, on the raising of the Big Meadows dam at Lake Almanor, and upon the construction of a tie-line between the two systems which will be designed for ultimate operation at 220-kv.," said Mr. Wilson.

Mr. Wilson said that A. G. Wishon, now vice-president and managing director of the San Joaquin Co., would be elevated to the presidency and that A. Emory Wishon would be retained in his position as general manager with additional duties as vice-president. "The acquisition of control of the San Joaquin Light & Power Corp. by the Western Power Corp. has no significance, in so far as the conduct of the corporation is concerned. It is merely the change of ownership and control," said Mr. Wilson.

Bridge River Power Site May Be Bought by Railway

An extensive survey and investigation of the power site and permits of the Bridge River Power Co. on Bridge River in British Columbia is being made by the British Columbia Railway Co., with a possible view to purchasing of such property and rights for future hydro-electric power development. The plans of the Bridge River Power Co. called for an initial development of 62,400-kva., under a head of 1,140 ft., out of a potential development of 335,000 kw. It is understood that British Columbia Electric Railway Co. will decide during the present year whether to purchase the Bridge River site or make another power development on Stave River.

Ashley Street To Experiment With Unit Pulverizer

After a year of successful operation of its Cahokia station on pulverized fuel, the Union Electric Light & Power Co., St. Louis, Mo., has decided to experiment with the unit system of firing at the Ashley Street plant, according to the February issue of *Wire and Pipe*.

The present plans are to convert for observation, one of the twenty-four lower-deck boilers into a pulverized-fuel burning unit, with a view to determining whether or not the system could be advantageously used in the whole station, and if so, just what special design features should be incorporated. Practically no changes will be made in the boiler proper, but the furnace will be materially enlarged and rebuilt to burn pulverized coal. The furnace walls will be water-cooled by placing rows of regular boiler tubes connected to the boiler, along each side of the furnace. The tubes are to be protected from the extreme furnace temperature by a thin layer of refractory held in place by small castings clamped to the tubes. The coal will be fired by a simplex type pulverizer, the order for which has already been placed.

Bill To Regulate Power Use of Canal Water

A bill introduced into the New York Legislature on Feb. 17 by T. J. McDonald, would amend Chapter 147 of the Laws of 1903, which is the law providing for the expenditure of the $101,000,000 to build the barge canal, by adding a new section, 16-a, which would confer jurisdiction upon the superintendent of public works to collect money for the use of waters, surplus or otherwise created or impounded as a result of the improvement of the New York State canal system.

A survey of the barge canal by the *Albany Evening News*, in 1924, developed the fact that many mercantile concerns were using waters of the canal for power purposes.

The amendment introduced provides that no firm or corporation shall take or use any of the waters without a permit; that every person or corporation now using any of such waters shall apply for permission for such use within 60 days of the time the amended law takes effect. The violation of the provisions will subject the offender to a penalty of $500, and to an additional penalty of $50 a day for each day of continuance. It also provides for a system of appraisal to determine the value of the water used.

Hydraulic Power Exhibition in Basle in 1926

There will be held an International Exhibition for Inland Navigation and Utilization of Hydraulic Power in Basle, Switzerland, from July 1 to Sept. 15, 1926. The exhibition, which is being held in honor of the opening of the new Rhine port, is intended to present an idea of the development and present progress of navigation on inland waterways in various countries and the utilization of these waterways for power production.

The exhibition, which is to be held in the permanent buildings of the Swiss Industries Fair and on the open spaces adjacent, as well as upon the Rhine River, will have a large section devoted to power-plant stations, both low and high head, methods of regulating and correcting waterways, dams, weirs, basins, canals, pressure conduits, and also to turbines, pumps, generators, motors, switchboards, accessories and appliances.

Information as to the price of booths, transport and customs, etc., may be had from the organizing secretary, Dr. W. Krasting, Basle, Switzerland. Applications for participation in the exhibition should be made before September, 1925, and must be sent in not later than Dec. 31, 1925.

A. I. E. E. Tentative Program for Spring Convention

The American Institute of Electrical Engineers, 33 West 39th St., New York City, has prepared the preliminary program for its spring convention which is to be held at St. Louis, Mo., from April 13 to 17. Papers of interest to *Power* readers are as follows:

"Trenton Channel Station," by C. F. Hirshfeld, Detroit Edison Co.; "Cahokia Station," by H. W. Eales and Mr. Tenney, of the Union Electric Light & Power Co.; "Informal Discussion of Philo Station," by E. H. McFarland, Beach Bottom Power Co.; "Weymouth Station," by I. E. Moultrop, Edison Illuminating Co. of Boston; "Crawford Avenue Station"; "Interconnection of Systems with Frequency Changers," by H. R. Woodrow, Brooklyn Edison Co.; "Initial and Sustained Short-Circuits in Synchronous Machines," by V. Karapetoff, Cornell University; "Short-Circuit Currents of Synchronous Machines," by R. F. Franklin, General Electric Co.; "A Two-Speed Salient-Pole Synchronous Motor," R. W. Wieseman, General Electric Co.; "Self-Excited Synchronous Motors," by J. Kostko; "Electricity in the Cement Industry," by T. H. Arnold, Southwestern Portland Cement Co.; "Synchronous-Motor Drive for Rubber Mills," by O. W. Drake, Westinghouse Electric & Manufacturing Co.; "Use of Purchased Power in Glass Manufacture," by A. L. Harrington, Pittsburgh Plate Glass Co.

Honors Veteran Engineers With Medals

On Thursday evening Feb. 5, the Engineers' Division of the Metropolitan Life Insurance Co. at the Home Office in New York City, tendered a dinner and dance to three of its veteran members for 20 years or more of faithful service in the employ of the company. F. H. Ecker, vice-president, presented Niel Bonner with a 25-year medal and Messrs. John Kehrt and Joseph O'Brien with 20-year medals.

Following the presentation a dinner was served by the commissary department of the company, after which, J. F. Carman, chief engineer, acting as toastmaster, speeches were made by Vice-President J. C. Knight and several department heads.

Chicago A S. M. E. To Hold Machine-Tool Meeting

With the successful power meeting held in January, now a matter of history, the Chicago Section of the American Society of Mechanical Engineers has turned its attention to another division of the mechanical field, that of machine tools, and is now active in preparing a program more comprehensive than usual covering various phases of the machine-tool field from the users' viewpoint. This is in response to repeated suggestions from the membership that more attention be given to the machine-tool industry, and it is the plan, if the initial attempt meets with the proper response, that the meeting will be made an annual affair for the section.

The meeting will be held on March 11, with afternoon and evening sessions, the former to be held at the rooms of the Western Society of Engineers and the evening meeting at the City Club.

The afternoon program is as follows: "Trend of Machine Tool Design," author to be announced; "What We Want in Machine Tools" by Robert R. Keith, superintendent, Chicago Tractor Works of the International Harvester Co.; "Die Cast versus Machined Parts" by S. A. Hellings, vice-president, Stewart Manufacturing Corp., Chicago.

In the evening there will be a dinner meeting starting at 6:30 at the City Club, followed by a symposium on "Finishing of Plane Surfaces," which will be divided into two sections, one dealing with large surfaces and discussing heavy milling machines and planers and the other section on small surfaces dealing with light milling machines and disk grinders. In the first section heavy milling machines will be discussed by a representation of the Ingersoll Milling Machine Co., of Rockford, Ill., and planers by Forrest E. Cardullo, chief engineer of the G. A. Gray Co., of Cincinnati. In the section dealing with small surfaces, light milling machines will be discussed by a representative of the Cincinnati Milling Machine Co. and disk grinders by F. E. Gardner, vice-president of the Gardner Machine Co., of Beloit, Wis.

The responses to the efforts of the program committee have been so favorable that a most interesting meeting is assured and a large attendance is anticipated.

Oil and Gas Power Week Plans Under Way

Three hundred and forty million horsepower is being generated in automobiles in this country today. Natural-gas engines, blast-furnace-gas engines, producer-gas engines and many kinds of oil engines are daily generating many millions of horsepower for all kinds of purposes. The total horsepower from oil and gas today dwarfs that from steam and water combined, reversing completely the conditions of a quarter of a century ago. The conservation of the oil and gas fuel used in this enormous output represents several million cubic feet of gas and gallons of oil.

Thus declares Dr. William F. Durand, president of the A.S.M.E., which, with fourteen other national technical organizations, will devote the week of April 20 to meetings throughout the country, at which leading problems of the conservation of oil and gas for power purposes will be discussed. The participating societies are: American Chemical Society, American Institute of Mining and Metallurgical Engineers, American Petroleum Institute, Society of Automotive Engineers, American Society of Naval Engineers, American Society of Refrigerating Engineers, National Association of Stationary Engineers, American Institute of Chemical Engineers, Society of Naval Architects and Marine Engineers, American Society of Marine Designers, National Safety Council, and the United States Bureau of Standards, Bureau of Mines and Geological Survey.

In addition the leading oil companies, manufacturers of oil and gas equipment, the users, operators and the engineering schools are all co-operating to the end of bringing out all the problems of conservation in this basic field, focusing the attention of the experts on economy and increasing the benefits that the people of this country have already derived from the power obtained from oil and gas. The National Committee is composed of: W. F. Durand, president of the A.S.M.E.; James F. Norris, president of the A.C.S.; J. Edgar Pew, president of the A.P.I.; C. E. Luckie; W. Trinks; L. H. Morrison; and W. E. Bullock, secretary, 29 West 39th St., New York City.

Muscle Shoals Conference Bill Faces Filibuster

AS this is written, the conference report on the Muscle Shoals bill is facing a filibuster. The chances seem to be about equal as to whether or not Congress will have an opportunity to pass finally on this legislation. It is quite generally admitted that should the opponents of the bill muster enough strength to keep a filibuster going for three days, the Senate would vote to withdraw it rather than sacrifice other legislation.

While the fertilizer industry is anxious to see the Underwood bill killed, the interests of the power companies apparently would not be affected greatly by any action or lack of action on the part of the Senate. If the conference report is approved, it is expected that the power companies will renew their fertilizer offer. If the bill fails, they will have the opportunity to lease the power under the custodial authority of the Secretary of War.

Seattle's $8,000,000 Skagit Project

The Seattle, Wash., City Council has passed an ordinance providing for the issuance of $15,000,000 in city light bonds, of which $8,000,000 is to be used in further development of the Skagit project at Ruby Creek, and $7,000,000 will be expended for extension of electric lines, purchase of five substations, and equipment for the lighting plant.

The development at Ruby Creek will increase the power of the Skagit project and is expected to provide between 75,000 and 80,000 primary horsepower. The present Gorge Creek unit provides 56,000 hp. at high water and 23,000 at low water, which is about half the year.

Plans provide for a storage dam at Ruby Creek, 330 ft. high measured from bedrock to crest, located nine miles above the present timber-crib dam at Gorge Creek and just below the junction of Ruby Creek with the Skagit.

A further development at Gorge Creek would have provided approximately 80,000 hp. at high water, with the low-water development remaining the same as at present.

Employment Service To Open Chicago Office

The board of directors of the Employment Service, which has been established by four of the national engineering societies, has taken up actively with the Chicago section of the A.S.M.E. and through this section, with the Western Society of Engineers, the possibility of opening a Chicago office of the Employment Service. Negotiations are also being conducted with the San Francisco section of the A.S.M.E. with a view to establishing a branch office there, in the spring.

The Employment Service has been partly self-supporting through the voluntary contributions from men finding positions through it and from subscriptions to a Bulletin of positions available. Recently, as announced in *Power*, Jan. 13, an *Employers' Bulletin* has been added to further increase the service rendered and the income. So far, the financial success has been of such a nature as to lead to the hope of nationalizing the service by opening additional offices in key cities throughout the country. The anticipated opening of offices in Chicago and San Francisco will be the first definite step in this direction.

The board of directors of the Employment Service consists of the secretaries of these four national engineering societies.

Lowell Steam Station To Be Enlarged

The Lowell Electric Light Corp. has awarded a contract to design and build an addition to its Perry Street steam station to Stone & Webster, Inc., 147 Milk St., Boston, Mass. The new turbo-generator will have a capacity of 12,500 kw. and will be equipped with surface condenser and auxiliaries. The turbine room will be enlarged and the necessary condenser circulating water augmented by additional tunnels. The electrical switchboard will also be consolidated.

Capitol Power Plant Needs Repairs

The budget has approved a supplemental estimate for $251,800 covering repairs, replacements and betterments for the power plant in the Capitol Building. This plant also serves the near-by Senate and House office buildings and the Library of Congress.

The work consists of the installation of eight new stokers, together with structural changes and the work incident thereto; changes in feed-water system; new turbo-electric exciter and storage battery; turbo-generator repairs; and conserving condensation from the heating system.

The Iowa Engineering Society Honors Memory of Dunlap

Honoring the memory of the late John H. Dunlap, secretary of the A.S.C.E., the Iowa Engineering Society recently decided to make an annual award to the Iowa engineer whose work had been most meritorious in the field of engineering the preceding year.

Mr. Dunlap was for fourteen years a member of the faculty of the State University of Iowa and as such became an integral part of the engineering life of Iowa. This tribute to his memory and standards is particularly appropriate.

Power Commission Makes Decision On Data

Stream flow and other data which have been compiled by an applicant under the Water Power Act will not be made available to another applicant for the same rights even if the rights granted the first applicant should be allowed to lapse. A decision to this effect was rendered recently when an applicant for a preliminary permit was not in position to apply for a license after his permit had been extended to the legal limit. A prospective applicant for a preliminary permit covering the same power site took the position that he should not be required to undergo the expense incident to duplicating the information already in the hands of the commission.

The data will be turned over to the new applicant if the former applicant definitely abandons the project, but in most cases the earlier applicant expects later to qualify for license. Even if a preliminary permit were granted to another, the chance would exist that he might not be in a position to qualify for a license at the expiration of the permit, whereupon the original applicant then could step in and qualify.

Great Florence Lake Tunnel Holed Through

On Feb. 18 at 10:40 a.m. the tunnel that is to unite the flood waters of Florence Lake and the storage waters of Huntington Lake in the San Joaquin Valley of California was finally holed through. This tunnel, which is thirteen and one-half miles long, the longest tunnel in the world for hydro-electric purposes, and 15 ft. in diameter, has been drilled 10,000 ft. below the peak of Keiser Mountain, one of the Sierras. The tunnel is the result of five years of patient effort, at a cost of $17,000,000 expended by the Southern California Edison Co. as a part of its Big Creek project.

The additional power made available will eventually increase the company's production of electric energy to 253,000,000 kw.-hr., it is estimated.

Doherty's Plan to Conserve Oil During Production

Henry L. Doherty on Feb. 18 at the convention of the American Institute of Mining and Metallurgical Engineers, which was held at 33 West 39th St., New York City, outlined his rather drastic and practical plan for supervision of oil production. The following are the outstanding points in his plan:

That no land shall be drilled for oil until opened up by a government permit; that all land within drainage distance of existing production shall be opened for drilling; that permission to drill land not subject to drainage shall be granted only when an oil exploration district has been formed; all land embraced in the district which is one half mile or more from the outer boundaries shall be opened for drilling without restriction; no drilling shall be done on the outer strip of one-half mile except with the consent of all land holders within one-half mile of the proposed well, and wells located in this strip can be drilled only for exploration purposes, but must not be allowed to produce; if the owners cannot agree, then each must submit plans to the proper officer of the government, and this officer shall select one of the plans or submit a plan of his own, which shall be final. The plan adopted by the government official can be modified in case of subsequent agreement between the two districts.

Obituary

Charles Henry Wordingham, past-president of the Institute of Electrical Engineers (England) an authority on power generating and transmission systems, and the author of "Central Electric Stations," died after a prolonged illness on Jan. 28, at Redhill, England. He was born at Steretford, near Manchester, in 1866. Educated at King's College School and King's College, he entered the employ of Dr. John Hopkinson, where he carried experimental research work. He was employed by the London Electric Supply Corp., was in charge of the erection of the Manchester and Whitehaven central stations, and was chief electrical engineer of the Manchester Corporation for many years until in 1901 he retired to take up consultive work. He was a member of the Institution of Mechanical Engineers, Institution of Civil Engineers and a founder of the Electrical Development Association.

Personal Mention

H. B. Jones, formerly chief engineer of the Susquehanna Collieries Co., at Lykens, Pa., has resigned to join the engineering staff of the Fuller-Lehigh Co., manufacturer of pulverized-fuel equipment, at Fullerton, Pa.

Sir J. J. Thomson has been awarded the Faraday Medal by the Council of the Institution of Electrical Engineers (Eng.) The Faraday Medal is awarded for notable achievement in electrical engineering or for conspicuous service in electric science.

John J. Gaffey, formerly with the Edison Electric Illuminating Co. of Boston and later assistant engineering manager for the Harry M. Hope Engineering Co., has recently joined the engineering force of the station betterment division of Stone & Webster, Inc., Boston, Mass.

Society Affairs

The Eastern New York Section of the A.S.M.E., Schenectady Branch, will hold its March 6 meeting at the Edison Club Hall. Oscar Junggren, of the General Electric Co., will speak on "The Steam Turbine."

The Houston Section of the A.S.M.E. will have as the subject for its March 2 meeting, "The Engineering Profession—Its Antiquity and Its Obligations," by Dr. William F. Durand, president of the A.S.M.E.

The New Orleans Section of the A.S.M.E. will hear Dr. William F. Durand, president of the A.S.M.E., speak on "The Engineering Profession—Its Antiquity and Its Obligations," at its March 5 meeting.

The Metropolitan Section of the A.S.M.E. will hold a joint session on March 3, with the American Heating and Ventilating Engineers, at which the subject will be "Oil-Burning Heating Plants in Office and Mercantile Buildings."

The Tri-Cities Section of the A.S.M.E. will have as the subject of its Feb. 26 meeting, which will be held at the Davenport Chamber of Commerce at 6:45, "Muscle Shoals." Wilson P. Hunt, president of the Moline Tool Co., will be the speaker.

The Akron Section of the A.S.M.E. will hold a joint smoker-dinner meeting with the Student Branch of the University of Akron on Feb. 26. The subject will be "Engineering Reminiscences." Dean F. E. Ayer will be the toastmaster, with various members of the Akron section as speakers.

Business Notes

The American District Steam Co., North Tonawanda, N. Y., has appointed the Stanley Sales Co., No. 5 Great Jones St., as its New York City representative.

William R. Van Nortwick, who for the last seven years has been district sales manager at New York, for the Roto Co., Hartford, Conn., has severed his connections with that company and has opened offices at 50 Church St., New York City, for the sale of power-plant equipment.

The Joseph Dixon Crucible Co., Jersey City, N. J., manufacturer of graphite products, announces the removal of its Boston office from 49 Federal St., to 80 Federal St., Room 320. The district representatives are H. A. Neally, Charles A. Shaw, R. H. Brinkerhoff and J. W. Loftus.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., announces that Samuel D. Barr joined its service on Jan. 1 as manager of the Southern district with headquarters at 1019 Atlanta Trust Co., Bldg., Atlanta. He replaces David T. Newman, who will now be in charge of the western New York territory.

The Chicago-Wilcox Manufacturing Co., 6330 Stony Island Ave., Chicago, Ill., was incorporated on Feb. 2, 1925, to manufacture gaskets and packing, taking over the assets and liabilities of the Chicago Gasket Co. and the E. A. Wilcox Manufacturing Co., Inc. The new corporation is to have a new factory at East 77th St. and Anthony Ave., Chicago., which it expects to occupy in April of this year.

Trade Catalogs

Switchboards — Condit Electrical Manufacturing Co., South Boston, Mass. Leaflet describing this truck type of inclosed switchboard.

Ash Grates — Conveyors Corp. of America, Chicago, Ill. "American Flat Ash Gates" is the title of a leaflet recently received, which describes this rack-and-pinion type of ash gate.

Boilers—Kingsford Foundry & Machine Works, Oswego, N. Y. Catalog "Kingsford-Webster All Steel Sectional Water Tube Boilers," contains descriptions of the construction of these boilers and the illustrations show various installations as well as details.

Water Treatment—Paige & Jones Chemical Co., Inc., 248 Fulton St., New York City. "Ten Years' Achievements in Water Treatment, Softening and Filtration," is the title of a booklet recently issued by this company. Photos of the company's personnel and pictures of installations are included.

Pumps — Worthington Pump & Machinery Corp., 115 Broadway, New York City. "Worthington Centrifugal Pumps," is the title of Bulletin W-607 which has just been issued by the company. Careful descriptions and cross-section drawings of these pumps, as well as good illustrations, good paper and type, make this catalog attractive and useful.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Convention at Orlando, Fla., June 2-5.

American Association of Oil Burner Manufacturers. Leod D. Becker, Bank of Galesburg Bldg., Galesburg, Ill. Convention and exhibit at Edgewater Beach Hotel, Chicago, April 1-3.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Niagara Falls, April 23-25.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at St. Louis, April 13-17. Annual convention at Saratoga Springs, June 22-26.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting at Atlantic City, June 22-26.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Water Works Association. W. N. Niesley, 170 Broadway, New York City. Convention at Louisville, Apr. 27-May 3.

Canadian Association of Stationary Engineers. Geo. J. Soucy, 48 Moore Ave., Toronto, Ont., Secy. Convention at Windsor, June 29-July 1.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Kansas Association** at Topeka May 6-8. J. M. Van Sant 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **New England States Association** at Worcester, Mass., July 10-12, formerly announced June 18-20. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Megohmmeter—Herman H. Sticht & Co., 15 Park Row, New York City. "The 2 in 1 Megohmer," is the title of Bulletin No. 135 recently issued by this company. This instrument is a combination of megohmmeter and voltmeter.

Motors — Electric Machinery Manufacturing Co., Minneapolis, Minn. Synchronous motors for pumping are described in Bulletin No. 861, with many illustrations of installations, curves and tables of speeds. Bulletin No. 785-A gives a list of some of the users of these motors.

Pulverizing Equipment — Kennedy-Van Saun Manufacturing & Engineering Corp., 50 Church St., New York City. A general catalog, "Kennedy Products," seventh edition, covering crushers, mills, elevating and conveying machinery, pulverizers of powdered coal for power, etc., manufactured by the company, gives complete descriptions of these products with tables of data and good illustrations.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	Feb. 16, 1925
Pool 1	New York	$2.50@$2.90
Smokeless	Boston	1.72
Clearfield	Boston	1.75@ 2.20
Somerset	Boston	1.90@ 2.35
Kanawha	Columbus	1.50@ 1.70
Hocking	Columbus	1.50@ 1.75
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.25@ 1.35
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	$2.25@$3.50
Buckwheat No. 1.	Philadelphia	2.50@ 3.50
Birdseye	New York	1.60

FUEL OIL

New York—Feb. 18, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 17, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6@6.5c. per gal.

Pittsburgh—Feb. 17, f.o.b. local refinery; 30@34 deg., fuel oil, 6¾c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Dallas—Feb. 14, f.o.b. local refinery, 26@30 deg., $1.80 per bbl.

Philadelphia—Feb. 14, 28@30 deg., $2.73@$2.793 per bbl.; 18@22 deg., $2.42@$2.483; 13@16 deg., $2.10@$2.163 per bbl.

Boston—Feb. 16, tank-car lots, f.o.b.; heavy oil, 12@14 deg., Baumé 4½c. per gal.; light oil, 28@32 deg. Baumé, 5 5/16c. per gal.

Cincinnati—Feb. 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

New Plant Construction

Calif., Hemet—City is having plans prepared for the construction of two, 14 in. wells, pumps and motors, supply lines, reservoir, etc. Estimated cost $100,000. Burns-McDonnell-Smith Engineering Co. Marsh Strong Bldg., Los Angeles, is engineer.

Calif., Huntington Park—City is having plans prepared for the construction of water works improvements, including 200,000 gal. elevated tank and tower; 100,000 gal. reservoir; 1 centrifugal pump, with electric motor; hydrants, etc. Estimated cost $25,000. P. E. Kressly, H. W. Hellman Bldg., Los Angeles, is engineer.

Conn., New Haven—A. S. Friend, 36 West 44th St., New York City, plans the construction of a theater and office building, on College St. Estimated cost $1,000,000. Engineer and architect not selected.

Fla., Jacksonville—Famous Players Lasky Corporation, 485 Fifth Ave., New York City, plans the construction of a theater and office building here. Estimated cost $750,000. Engineer and architect not selected.

Fla., St. Augustine—E. Masters, City Manager, will receive bids until March 23 at the office of the City Commission, for waterworks improvements including, mains, valves, tank foundations, pumping equipment, wells and pumps, pumping station, and 300,000 and 60,000 gal. tanks on towers. J. E. Craig, 427 King St., Jacksonville, Fla., is consulting engineer.

Fla., South Jacksonville—City, will hold an election on March 4th, to vote $56,000 bonds for extensions to electric light plant. P. C. Marion, is chairman of commission.

Fla., Tampa—City will hold an election, March 17, to vote $1,000,000 bonds, for the construction of a municipal hospital. W. E. Duncan is clerk.

Idaho, Lewiston—The city pans an election to vote $1,200,000 bonds. Approximately $900,000 will be expended for the construction of a dam, across the Clearwater River, 4 miles above the confluence of the Clearwater and Snake Rivers, the balance for a hydro-electric power plant about 1½ miles below the dam.

Ia., Iowa Falls—City plans to purchase additional pumping equipment for waterworks.

Ia., Plover—City awarded contracts for mains, hydrants, tank on tower, etc., for water works system. Bids will be received later for pumping machinery. W. E. Buell & Co., 205 Davidson Bldg. Sioux City, are engineers.

La., Mansura—Bd. of Alderman will receive bids until February 25, for the construction of an electric light plant, and waterworks, improvements. Equipment includes one 50 hp. and one 100 hp. crude oil engine; one 500 gpm. sewer pump; 2 electric driven air compressors; 8-in. centrifugal pump, 68,000 gal. reservoir, etc. Estimated cost $55,000. F. J. Joseph, Glenmore, is consulting engineer.

La., Shreveport—Southwestern Gas and Electric Co. is having plans prepared and will take bids after March 1 for the construction of a power plant on Pierre Ave. Estimated cost $300,000. E. F. Neild Merchant Bldg. is architect. Company engineers in charge.

Mass., Arlington—Arlington Belmint Ice Co., plans the construction of an ice plant at Spy Pond. Estimated cost $150,000. Engineer not selected.

Mass., Lowell—Lowell Electric Light Corporation, 20 Market St. awarded contract for the construction of an addition to power plant on Perry St., to Stone & Webster, Inc., 147 Milk St., Boston.

Mass., Needham—Bd. of Selectmen, W. K. Queen, Chr., plans the construction of a new sewerage system and pumping station. Barbour & Dixon, Tremont Bldg., Boston, are engineers.

Mass., Reading—Bd. of Selectmen, B. Knight, Chn., plans the construction of an electric power plant. Estimated cost $80,000. Engineer not selected.

Mich., Detroit—Beldon Building Co., c/o C. N. Agree, 1133 Book Bldg., Archt., will soon award contract for the construction of a 10 story apartment house, including elevators and steam heating system, at Cass and Kirby Aves. Estimated cost $500,000.

Minn., Bloomington (Minneapolis P. O.)—Minnesota Masonic Homes Corporation, c/o A. F. Pray, 300 Oneida Bldg. Minneapolis, has had plans prepared for the construction of a 3 story lodge building and power house, at the Masonic Home. Estimated cost $300,000. Bertrand & Chamberlin, 616 Northwestern Bank Bldg. Minneapolis, are architects.

Minn., Minneapolis—The Dayton Co., 7th St. and Nicollet Ave., and M. T. Baker, 517 Marquette Ave., are having plans prepared for the construction of a 12 story office building, at 7th and Marquette Ave.; also a 12 story hotel at 8th St. and Marquette Ave., including steam heating systems. Estimated cost $1,000,000 each. Larson & McLaren, 816 2nd Ave., are architects.

Mo., Glendale (Kirkwood P. O.)—Town plans an election on March 14, to vote $60,000 bonds, for water distribution system, including booster pumps, etc.

Mo., Kansas City—Bd. of Fire and Water Commrs., A. J. Stewart, Pur. Agt., will receive bids until March 17 to 21, inclusive, for filtration plant, pumping stations, pressure tunnels, steel pipe conduits, pumps, motors and equipment. Contracts 1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. Contract 7—for furnishing two 24 m.g.d. and eight, 35 m.g.d. centrifugal pumps without motors; three, 2,500 g.p.m.; two, 500 g.p.m., and two 250 g.p.m. centrifugal pumps with motors. Contract 8—Two, 2,000 hp. and eight 400 hp. synchronous motors, and five, 30 kw. motor generator sets. Contract 9—Three switchboards and appurtenances. Contract 10—One outdoor substation. Contract 12—Filtration plant, consisting of twenty-four, 4 m.g.d. units, a secondary pumping station, designed for five, 35 m.g.d. electric motor driven units, etc. Contract 13—Intake on the Missouri River, and low lift pumping station, etc. Fuller & Maitland, 600 Walnut St., are engineers.

Mo., Kansas City—Sears, Roebuck & Co., Arthington and Homan Sts., Chicago, Ill., awarded general contract for the construction of a mail order house at Cleveland Ave., and 15th St. here, to B-W. Construction Co., 729 Cass Ave., Chicago. Estimated cost $4,000,000. The plans include a 2 story administration building, a 9 story merchandise building, and power house. Lieberman & Hein, 190 North State St., Chicago, are engineers. G. C. Nimmons & Co., 122 South Michigan Ave., Chicago, are architects.

Mo., Kirkwood—City voted $25,000 bonds for power equipment for waterworks, including engines and generators, etc., $30,000 for repairs to electric light distribution system. C. E. Smith, Railway Exchange, St. Louis, is engineer.

Mo., St. Louis—Union Electric Light and Power Co., L. H. Egan, Pres. plans to expend $11,000,000 for improvements and extensions, during 1925. The plans include laying six new cables at the bottom of the Mississippi River, connecting St. Louis with power plant at Cahokia, Ill.; conversing St. Charles St. and Lucas Avenue substations, into automatic substation; doubling the capacity of Kingshighway boulevard substation; increasing the capacity of Chippewa, Enright, Penrose, Page Ave. and South Broadway substations. Total estimated cost $1,639,000.

N. C., Chimney Rock—Chimney Rock Mountains, Inc., has had plans prepared for the construction of a dam and 13,500,000 kw. capacity per annum hydro-electric installation, on Rocky Broad River, near here.

N. C., Elizabeth City—Utility Commission, W. B. Goodwin, Chm., will receive bids until March 18th for 6 vertical, slow speed, sewage pumping units, complete with motors, starters etc. also sewage pumping stations, tanks, pipe, etc. W. G. Olsen, Raleigh, is engineer.

O., Euclid—Bd. of Education, 1550 Chardon Rd., J. B. Clark, Clk. is having plans prepared for the construction of a grade school on Upson Rd. including 40 x 48 ft. boiler house. Estimated cost $200,000. Fulton & Taylor, 8120 Euclid Ave., Cleveland, are architects.

O., Dayton—Telling—Belle Vernon Co., 3825 Cedar Ave., Cleveland, awarded contract for the construction of a 2 story, ice cream factory, here to H. R. Blagg Co., 1229 East 3rd St., Dayton. Estimated cost $80,000.

O., Sterling—Sterling Ice Co., W. E. Arbogast, Mgr. is in the market for complete equipment for new ice manufacturing plant.

Okla., Quinton—City, H. J. Byers, Clk., will receive bids until March 5, for the construction of a filter plant and filter equipment in two units of 100,000 g.p.d. each, centrifugal pumps, natural gas engine, marine type; two, 150 g.p.m., 120 ft. head with alternate on one motor driven and one marine engine, 50,000 gal. tank on tower, etc.

Okla., Touhawa—City, voted $80,000 bonds, for the construction of waterworks including dam across the Chickaskia River, filter plant, settling basin, and equipment including motor driven pumps, etc.

Pa., Arbridge—Water Commission, Borough Bldg., Merchant and 10th Sts. D. M. Cooper, Pres. will receive bids until March 5, for 1, triplex pump, capable of furnishing 1½ million gal. of water every 24 hrs. against a combined suction and discharge head of 300 ft.; 1, vertical multiple cylinder, four cycle, natural gas engine of not less than 116 break hp.

Pa., Philadelphia—Philadelphia Q. M. Depot 21st St. and Oregon Ave., will receive bids until March 9, for the construction of a boiler auxiliary house.

Tenn., Memphis—L. Bruce Co., P. O. Box 1526, is in the market for two, 200-250 kw., 440 v., 60 cy., 3 phase turbo generator; or direct connected engine and generator.

Tex., Houston—N. Esperson, National Bank Bldg. will receive bids about March 1, for the construction of a 24 story office building on Travis St. Estimated cost $2,000,000. J. Eberson, Chicago, Ill. is architect.

Tex., McAllen—H. P. Smith, National Bank of Commerce Bldg. San Antonio, Archt., will soon receive new bids for the construction of a group of college buildings, including boiler room and engine house for Carroll College, J. M. Carroll, Pres. Estimated cost $300,000. Former bids rejected.

Va., Martinsville — Southern Virginia Power Corporation awarded contract for the development of a hydro-electric plant, including a dam 50 ft. high and 700 ft. long, and power house to contain three 1,200 hp. units, on the Smith River, near here, to Ambursen Construction Co., Grand Central Terminal, New York City.

Wis., Jefferson Junction—Ladish Co., 105 Wells St., Milwaukee, awarded contract for the construction of a 4 story feed mill, here, to Burrell Engineering Co., 513 West Jackson Blvd., Chicago, to replace fire loss. Estimated cost $50,000. Complete equipment including conveying machinery, electric motors, etc., will be required.

Wis., Milwaukee—Everpure Ice Co., 1500 Walnut St., awarded contract for the construction of a 2 story, addition to ice manufacturing plant, to Charles Harp, 1157 49th St.

B. C., Marpole—United Distillers Ltd. awarded contract for the construction of a distillery to Smith Bros. & Wilson, Vancouver. Estimated cost $400,000. First unit consists of granary, distillery and fermenting building, boiler house, drying house, etc.

Ont., Highgate—The Town, F. Littlejohns, Clk., plans the construction of waterworks and fire protection system, including pumps, motors, valves and pumphouse. Engineer not selected.

Ont., London—Utilities Commissioners, E. V. Buchanan, Gen. Mgr. is in the market for Diesel oil engine, either, two, 750 hp. units, or one, 1500 hp. Estimated cost $100,000.

Ont., Ottawa — Ontario Hydro Electric Comm., A. Beck, Chn., Toronto, plans a 100,000 hp. hydro-electric development, at Chat Falls, 25 miles above Ottawa, and at Rock Foudu near Calumet Island, Ottawa River. Estimated cost $800,000.

Ont., York—Firstbrook Bros., 283 King St. East, Toronto, Ont., plan the construction of a factory for the manufacture of wooden boxes, and cartons, on recently purchased site here. Estimated cost $200,000. Complete equipment including electric motors will be required.